



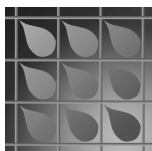
Construction Stormwater Control Technical Requirements Manual

Issued July, 2000



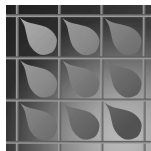
The City of Seattle

Title 22.800 Stormwater, Grading & Drainage Control Code



Volume 1: Source Control Technical Requirements Manual
Volume 2: Construction Stormwater Control Technical Requirements Manual
Volume 3: Flow Control Technical Requirements Manual
Volume 4: Stormwater Treatment Technical Requirements Manual

Stormwater, Grading & Drainage Control Code



Volume 1: Source Control Technical Requirements Manual

Volume 2: Construction Stormwater Control Technical Requirements Manual

Volume 3: Flow Control Technical Requirements Manual

Volume 4: Stormwater Treatment Technical Requirements Manual

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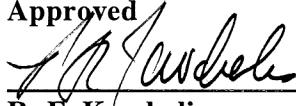
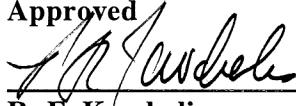
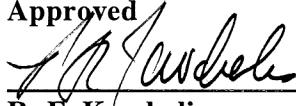
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The City of Seattle

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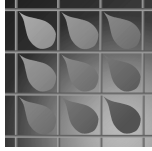
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Introduction

This **Construction Stormwater Control Manual** details temporary erosion and sediment control technical requirements and plan submittal requirements to help ensure controls are implemented. DCLU and SPU produced this manual in direct response to amendments of Seattle Municipal Code 22.800 – 22.808, adopted by City Council on June 5, 2000. The code was revised in part to improve water quality by reducing erosion from construction projects. The adoption of this rule supersedes DCLU Rule #6-93.

Construction Stormwater Controls are defined as physical, structural and/or managerial practices, that when used singly or in combination, prevent or reduce water pollution. This manual contains the following:

- **Chapter 1** covers the submittal process for drainage permit applications.
- **Chapter 2** explains how to use a simple matrix to select construction stormwater controls for your project.
- **Chapter 3** contains general standards and specifications for erosion and sedimentation control.
- **Chapter 4** details the practices that control pollutants other than sediment.



Chapter One

The Submittal Process

Projects Requiring Drainage Control Review

If your project involves any of the following activities, you must apply for drainage control review and approval (SMC 22.802.020 A):

- Any land disturbing activity encompassing an area of 750 square feet or more;
- Applications for either a master use permit or building permit that includes the cumulative addition of 750 square feet or more of land disturbing activity and new and replaced impervious surface;
- Applications for which a grading permit or approval is required;
- Applications for street use permits for the cumulative addition of 750 square feet or more of new and replaced impervious surface and land disturbing activity after the effective date of the Ordinance codified in this Subtitle;
- City public works projects or construction contracts, including contracts for day labor and other public works purchasing agreements, for the cumulative addition of 750 square feet or more of new and replaced impervious surface and land disturbing activity to the site after the effective date of the Ordinance codified in this Subtitle, except for projects in a City-owned right-of-way and except for work performed for the operation and maintenance of park lands under the control or jurisdiction of the Department of Parks and Recreation;
- Permit approvals and contracts that include any new or replaced impervious surface on a site deemed a potentially hazardous location, as specified in Section 22.800.050; or
- Whenever an exception to a requirement set forth in this Subtitle or in a rule promulgated under this Subtitle is desired, whether or not review and approval would otherwise be required, including but not limited to, alteration of natural drainage patterns or the obstruction of watercourses.

Permit Application Submittal Requirements

All activities that are required to apply for drainage control review and approval must submit a *Construction Stormwater Control Plan* (22.802.020 B.1.b.). Pursuant to this rule, applications for MUPs without a demolition component are exempt from the requirement to submit a construction stormwater control plan.

What is a Construction Stormwater Control Plan?

A construction stormwater control plan consists of temporary and permanent controls to be used in construction to prevent erosion or transport of sediment or other pollutants from the site. The contents of a construction stormwater control plan vary with the amount of new or replaced impervious surface, as described below.

1. Checklist

For projects of less than 5,000 square feet of new or replaced impervious surface or less than 1 acre of land disturbing activity, an applicant need only complete and sign a *Construction Stormwater Control Checklist* (Figure 1) at the time of application to be in compliance with 22.802.020 B.1.b.

Note of Future Requirements: By January 1, 2001, some projects less than 5,000 square feet of new or replaced impervious surface (or less than 1 acre of land disturbing activity) may be required to submit a *Small Project Construction Stormwater Control Plan* if the project proposal includes a large amount of excavation, fill, dredging, or other movement of earth materials. This amount of excavation, fill, dredging, or other movement of earth materials is currently being reviewed. The *Small Project Construction Stormwater Control Plan* consists of a plan and narrative but would not likely require preparation by a civil engineer. Potential requirements under consideration for the plan include:

- A. Provide the name, address, and phone number of the owner or contact person.
- B. Designate north arrow, lot number and plat, address, date, and street name fronting structure.
- C. Show all existing and proposed structures on the site.
- D. Locate and size all stream, swales, and drainage channels on or within 25 feet of the site that may involve or affect the drainage of the site to be developed. Indicate all existing stormwater pipes and their diameters and lengths.
- E. Indicate the direction and location of surface water runoff entering and exiting the site from all adjacent property. This may be done with topographic contour lines.
- F. Indicate what types of systems will be used to convey runoff away from the proposed structures.
- G. Indicate how construction will be phased so that only those areas that are actively being worked are uncovered.
- H. Show all minimum stormwater controls to be used during construction and to permanently stabilize the site. For the required minimum controls, refer to the *Construction Stormwater Control Checklist*.
- I. Indicate the construction entrance.
- J. Indicate where excavated or stockpiled soil will be located.

Project Number _____ Project Address _____

Name of Responsible Party (print) _____

Figure 1. Construction Stormwater Control Checklist

For projects of less than 5,000 feet of new or replaced impervious surface, or less than 1 acre of land disturbing activity that do not require a grading permit pursuant to SMC 22.804.030 A. This is an agreement that the applicant and/or responsible parties will use the following stormwater controls as directed in completing a project that is subject to drainage control review and approval. At the time of application, the applicant and/or responsible party must check each box below, then sign this checklist, to be in compliance with 22.802.020 B.1.b. Numbers prefaced by "E" and "C" below refer to technical specification provided in Chapters 3 and 4 of the Construction Stormwater Control Director's Rule.

Requirements (pursuant to SMC 22.802.015 C3)	✓	Minimum Stormwater Controls
1. From October 1 to April 30, no soils shall remain unstabilized for more than two days. From May 1 to September 30, no soils shall remain unstabilized for more than seven days. Stabilize all soils, including stockpiles that are temporarily exposed.		Use one of the following to temporarily stabilize soils, including stockpiles: E1.10 Temporary Seeding, E1.15 Mulching and Matting, E1.20 Clear Plastic Covering, E2.20 Dust Control
2. After construction but before project shall be considered completed, permanently stabilize all exposed soils that have been disturbed during construction.		Use one of the following to permanently stabilize soils: E1.35 Permanent Seeding or Planting, E1.40 Sodding
3. Prevent the transport of sediment from the site.		Use one of the following to prevent the transport of sediment from the site: E3.10 Filter fence, E3.15 Straw bale barrier, E3.20 Brush barrier, E3.25 Gravel filter berm, E3.40 Sediment pond, E3.35 Sediment trap. Retaining natural vegetation and buffer zones are encouraged, but may not be used as a substitute
4. During construction, prevent the introduction of pollutants in addition to sediment into stormwater.		Comply with the requirements for each of the following construction related activities: C1.10 Pesticide Control, C1.20 Handling Petroleum Products, C1.30 Nutrient Application, C1.40 Solid Waste Handling/ Disposal, C1.50 Use of Chemicals During Construction
5. Limit construction vehicle access, whenever possible, to one route. Stabilize access points.		Comply with the requirements for each of the following: E2.10 Stabilization Construction Entrance, E2.15 Construction Road Stabilization Provide periodic street cleaning by sweeping or shoveling any sediment that may have been tracked out. Place sediment in a suitable disposal area where it will not erode again.
6. Inspect and maintain required erosion and sediment controls to ensure continued performance of their intended function.		Maintain stormwater controls as identified in #1-#3 above according to specifications prescribed in this rule (see Chapters 3 and 4 for more information).
7. Prevent sediment from entering all storm drains, including ditches, which receive runoff from the disturbed area.		Provide storm drain inlet protection (E3.30) for any drain that receives runoff from the disturbed area.

I agree to meet each requirement and use each stormwater control checked above to prevent erosion and sedimentation from leaving the site of project number _____. I understand that I may be required to use additional controls when the minimum controls established above are not sufficient to prevent erosion or transport of sediment or other pollutants from the site.

Signature of Responsible Party

Date

2. Large Project Construction Stormwater Control Plan

For projects of 5,000 square feet or more of new or replaced impervious surface or 1 acre or more of land disturbing activity, the applicant must submit a Large Project Construction Stormwater Plan to be in compliance with 22.802.020 B.2.d.

The Large Project Construction Stormwater Plan consists of two parts: narrative plan notes and a site plan (Figures 3-a and -b). The narrative plan notes verbally explain the problems and their solutions with all necessary documentation. Justification should be provided for all solutions. The site plan is a series of maps or drawings pictorially explaining information contained in the narrative, including representation of all minimum stormwater controls to be used during construction and to permanently stabilize the site. The site plan and any calculations on plan notes must be stamped and signed by an engineer licensed in the State of Washington.

Narrative Plan Notes shall include the following:

- A. Project description – Briefly describe the nature and purpose of the land disturbing activity and the amount of grading involved.
- B. Existing site conditions – A description of the existing topography, vegetation, and drainage.
- C. Adjacent areas – A description of neighboring areas such as streams, lakes, residential areas, roads, etc., that might be affected by the land disturbance. Provide perimeter control of runoff on all necessary property boundaries.
- D. Soils – A brief description of the soils on the site giving such information as soil names, mapping unit, erodibility, permeability, depth, texture, and soil structure.
- E. Construction stormwater controls – Identify all minimum construction stormwater controls as directed in Chapter 2 of the Construction Stormwater Control Director's Rule. Note: pursuant to these two sections of the code, the responsible party may be required to use additional controls when the minimum controls established above are not sufficient to prevent erosion or transport of sediment or other pollutants from the site.
- F. Calculations – Any calculations made for the design of such items as sediment ponds, diversions, waterways, and calculations for runoff and stormwater detention basin design. All calculations must bear the signature and stamp of an engineer licensed in the State of Washington.

The Site Plan must show the following:

- A. Vicinity map – A small map locating the site in relation to the surrounding area.
- B. Existing contours – Existing contours of the site.
- C. Existing vegetation – The existing tree line and generalized vegetation. If the site contains an Environmentally Critical Area, all trees and shrubs over 6 inches in diameter must be shown.
- D. Soils – Areas with potentially serious erosion problems.
- E. Indicate north – The direction of north in relation to the site.
- F. Existing drainage patterns – The dividing lines and the direction of flow for the different drainage areas must be shown on a map.

- G. Final contours – Changes to the existing contours must be shown on a map. Use a bold dashed line showing developed condition drainage divides.
- H. Limits of clearing and grading – Areas that are to be cleared and graded should be outlined on a map.
- I. Cut and fill slopes – Show all cut and fill slopes, indicating top/bottom of slope catch lines.
- J. Conveyance
 - a. Designate locations for grass-lines swales, interceptor trenches, or ditches.
 - b. Show all drainage pipes, ditches, or cut-off trenches associated with erosion/sediment control.
 - c. Provide all temporary pipe inverts or minimum slopes and cover.
 - d. Show grades, dimensions, location, and direction of flow in all ditches and swales.
 - e. Provide details of bypassing and controlling offsite runoff around clearing limits/disturbed areas and sediment pond/trap.
 - f. Indicate locations and outlets of any possible dewatering systems.
- K. Minimum construction stormwater controls – Show the locations of all minimum construction stormwater controls as directed in Chapter 2 of the Construction Stormwater Control Director's Rule to comply with SMC 22. 802.015 C.3 and 22.802.016 B.8. Include, but do not limit plan notations to:
 - a. Locations of sediment traps, ponds, and all associated pipes and structures.
 - b. Dimension pond berm widths, and all inside and outside pond slopes.
 - c. Trap/pond storage required and the depth, length, and width dimensions.
 - d. Typical section views throughout pond and outlet structure.
 - e. Typical details of gravel cone and standpipe, and/or other filtering devices.
 - f. Stabilization techniques for outlet/inlet.
 - g. Details of control/restrictor device location and details.
 - h. Details of mulch and/or recommended cover of berms and slopes.
 - i. Rock specifications and detail for rock check dam
 - j. Spacing provisions for rock check dam as required for slopes on site.
 - k. Front and side sections of typical rock check dams
 - l. Locations and provide details and specifications for geotextile fabric silt fence (include installation detail)
 - m. Any equipment washdown areas
- L. Detailed drawings – Any structural practices used that are not referenced to this rule should be explained and illustrated with detailed drawings.

Figure 2-a. Example: Large Project Construction Stormwater Control Plan

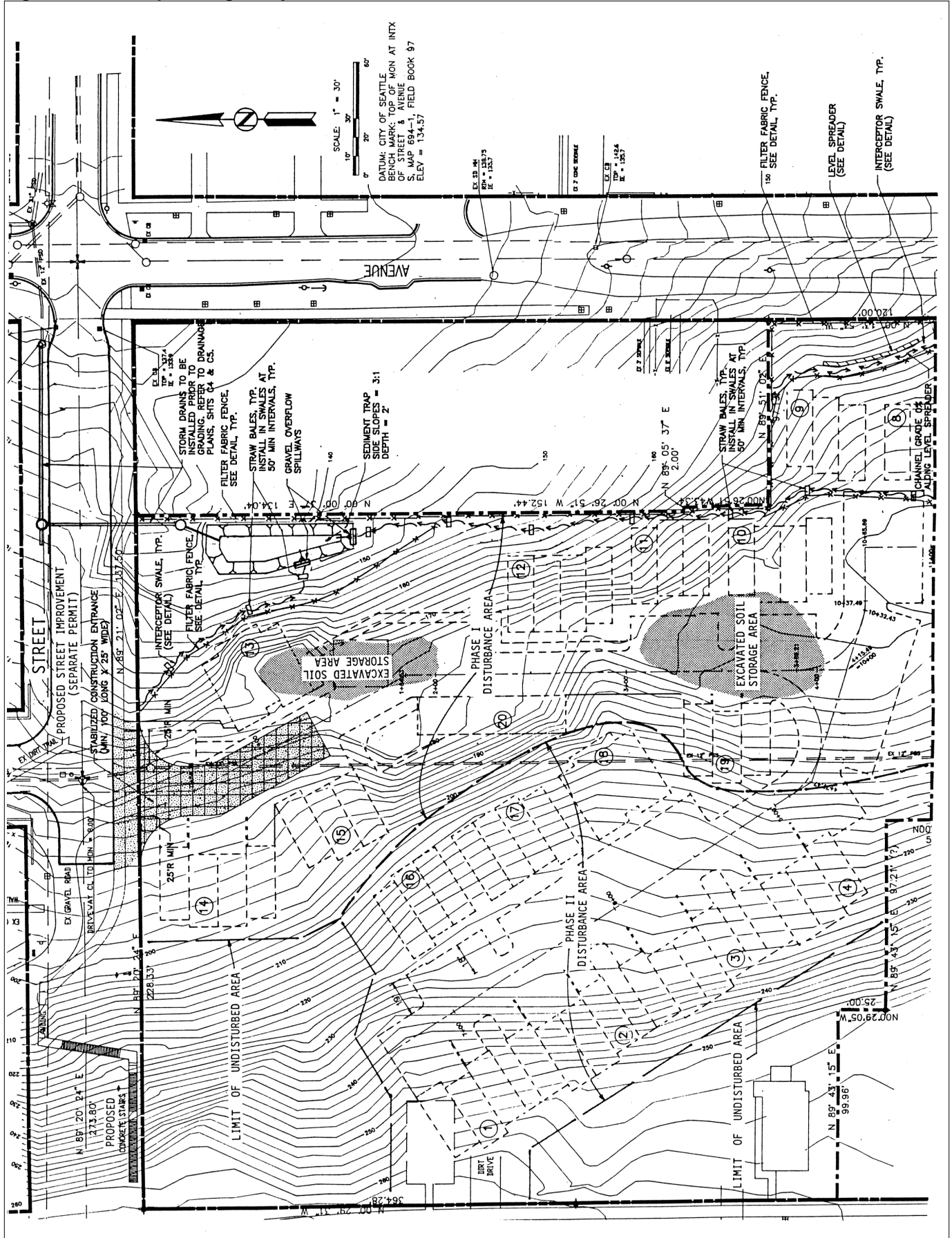
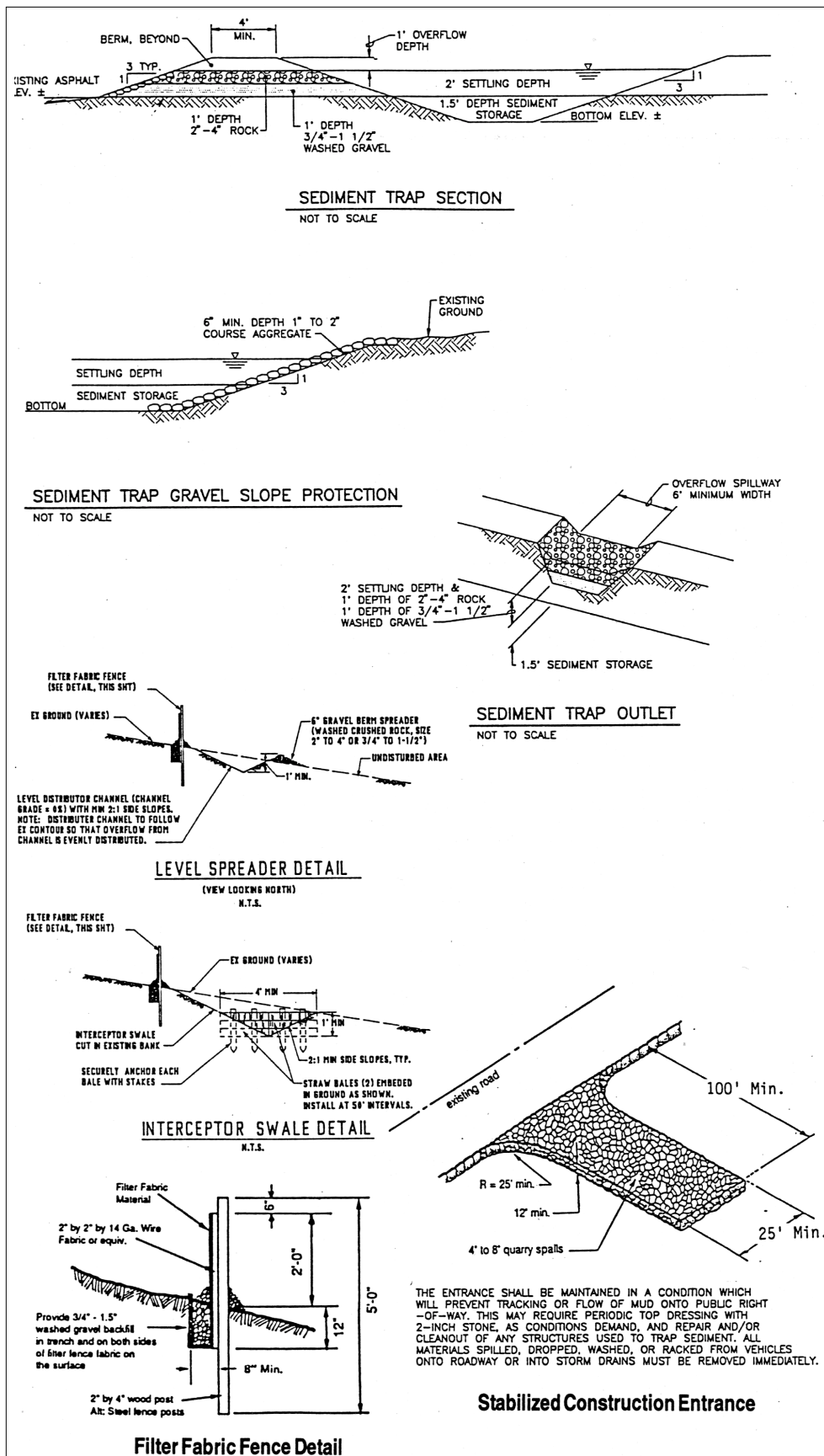


Figure 2-b. Narrative Plan Notes: Large Project Construction Stormwater Control BMP

**Erosion/Sedimentation Control (ESC) Notes:**

1. The implementation of these ESC plans and the construction, maintenance, replacement, and upgrading of these ESC facilities is the responsibility of the applicant/contractor until all construction is approved.
2. The ESC facilities shown on this plan must be constructed in conjunction with all clearing and grading activities, and in such a manner as to insure that sediment laden water does not leave the site, enter the drainage system or violate applicable water standards.
3. The EDC facilities shown on this plan are the minimum requirements for anticipated site conditions. During the construction period, these EDC facilities shall be upgraded (e.g. additional sumps, relocation of ditches and silt fences, etc.) as needed for unexpected storm events.
4. The ESC facilities shall be inspected daily by the applicant/contractor and maintained as necessary or as directed by the City of Seattle to ensure their continued functioning.
5. Any area stripped of vegetation, including roadway embankments, where no further work is anticipated for a period of 15 days shall be immediately stabilized with the approved ESC methods (e.g. seeding, mulching, netting, erosion blankets, etc.).
6. The ESC facilities on inactive sites shall be inspected and maintained.
7. Stabilized construction entrances shall be installed at the beginning of construction and maintained for the duration of the project. Additional measures may be required to insure that all paved areas are kept clean for the duration of the project.



Chapter Two

Construction Stormwater Controls — Selection Process

The purpose of this chapter is to define a process for selecting construction stormwater controls to demonstrate compliance with the construction stormwater drainage control requirements.

SMC Sections 22.802.015 C3 and 22.802.016 B8 require all standard and large projects to install temporary and permanent construction stormwater controls through a selection process specified in this Director's Rule.

Table 1 lists the construction stormwater control requirements as set forth in SMC Section 22.802.015 C3 for standard drainage control review and SMC Section 22.802.016 B8 for large project drainage control review. Table 1 correlates the construction stormwater controls described in this Rule with each of the construction stormwater control requirements for both standard and large projects. Table 1 prescribes which construction stormwater control methodology must be used to meet each requirement listed in SMC Sections 22.802.015 C3 and 22.802.016 B8. For some requirements, the table notes a specific control that must be used to meet the requirement. During pre-application site visit, the DCLU inspector may modify the specific control or select a different control from the list. If not directed otherwise to a specific stormwater control, the applicant must use one control for each requirement to meet the construction stormwater control requirement.

For some construction stormwater control requirements, the applicant is responsible for choosing the appropriate stormwater control or controls. The middle column of each table provides guidance on how to select the appropriate control. For other construction stormwater control requirements, DCLU will determine which control must be implemented. In addition, field inspections may result in modifications or additions to construction stormwater controls. Ultimately, the chosen construction control must be included in the Construction Stormwater Control Plan to demonstrate compliance with the construction stormwater control requirements set forth in SMC Sections 22.802.015 C3 and 22.802.016 B8, as appropriate.

Table 1. Construction Stormwater Control Selection

Requirement	Control Selection Process	Stormwater Control
1. Prevent on-site erosion by stabilizing all soils, including stock piles, that are temporarily exposed. From October 1 to April 30, no soils shall remain unstabilized for more than two days. From May 1 to September 30, no soils shall remain unstabilized for more than seven days.	The responsible party must apply one or more of the following:	E1.10 Temp Seeding E1.15 Mulching and Matting E1.20 Clear Plastic Covering E2.20 Dust Control
2. Before the completion of the project, permanently stabilize all exposed soils that have been disturbed during construction.	The responsible party must apply one or more of the following:	E1.35 Permanent Seeding/Planting E1.40 Sodding
3. Prevent the transport of sediment from the site.	The responsible party must apply a filter fence, straw bale barrier, gravel filter berm or brush barrier. A sediment pond or trap may be used in place of a filter fence, straw bale barrier or brush barrier. Retaining natural vegetation and buffer zones are encouraged, but may not be used as a substitute for a filter fence, berm or barrier.	E3.10 Filter Fence E3.15 Straw Bale Barrier E3.20 Brush Barrier E3.25 Gravel Filter Berm E3.35 Sediment Trap E3.40 Temporary Sediment Pond E1.25 Preserving Natural Vegetation E1.30 Buffer Zones
4. During construction, prevent the introduction of pollutants in addition to sediment into stormwater.	The responsible party must comply with requirements for each of the following construction related activities, C1.10 through C1.50. C1.60-2.20 currently written as guidance only.	C1.10 Pesticide Control C1.20 Handling Petroleum Products C1.30 Nutrient Application C1.40 Solid Waste Handling/ Disposal C1.50 Use of Chemicals during Construction C1.60 Managing Hazardous Products C1.70 Equipment Washing C1.80 Spill Control Plan and Clean-up C1.90 Contaminated Soils Treatment C2.00 Managing Concrete Trucks C2.10 Sandblasting C2.20 Handling Asbestos and PCBs
5. Limit construction vehicle access, whenever possible, to one route. Stabilize access points to minimize the tracking of sediment onto public roads.	All construction entrances must be stabilized as prescribed in this rule. All roads greater than 25' in length shall be stabilized within 1 week.	E2.10 Stabilization Construction Entrance E2.15 Construction Road Stabilization
6. Inspect and maintain required erosion and sediment controls to ensure continued performance of their intended function.	The responsible party must maintain all controls according to specifications prescribed in this rule.	NA
7. Prevent sediment from entering all storm drains, including ditches, which receive runoff from the disturbed area.	The responsible party must apply the following as specified by this rule:	E3.30 Storm Drain Inlet Protection

Table 1. Construction Stormwater Control Selection (continued)

Requirement	Control Selection Process	Stormwater Control
Additional Requirements for Large Projects (SMC 22.802.016 B8)		
1. Before leaving the site, stormwater runoff shall pass through a sediment trap, sediment pond, or similar device.	A sediment pond must be used. If site constraints prevent the use of a sediment pond, a sediment trap may be used if approved by the Director.	E3.35 Sediment Trap E3.40 Temporary Sediment Pond
2. In the field, clearing limits and any easements, setbacks, critical areas and their buffers, trees, and drainage courses shall be marked.	NA	NA
3. Sediment ponds and traps, perimeter dikes, sediment barriers, and other erosion and sedimentation controls intended to trap sediment on site shall be constructed as a first step in grading. These controls shall be functional before the land disturbing activities take place. Earthen structures such as dams, dikes, and diversions shall be stabilized in accordance with Section 22.802.015 C3.	NA—This requirement does not specify which control must be used, but when the controls must be installed.	NA
4. Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion. In addition, slopes will be stabilized in accordance with Section 22.802.015 C3 above.	One or more of the following controls is required, as specified by the Director.	E2.35 Surface Roughening E2.40 Gradient Terraces E2.45 Bioengineered Protection of Steep Slopes
5. Properties and waterways downstream from the project site shall be protected from erosion due to increases in the volume, velocity, and peak flow rate of stormwater from the project site and peak flow.	The responsible party must install a sediment pond to control runoff rates during construction.	E3.40 Temporary Sediment Pond
6. All temporary on-site conveyance channels shall be designed, constructed, and stabilized to prevent erosion from the expected velocity of a 2-year, 24-hour design storm for the developed condition. Stabilization adequate to prevent erosion of outlets, adjacent streambanks, slopes, and downstream reaches shall be provided at the outlets of all conveyance systems.	<p>The Director may require pipe slope drains or subsurface drains to prevent erosion during construction.</p> <p>Check dams, interceptor dikes and swales, and outlet protection may be required when specified by the Director to prevent downstream erosion.</p> <p>Vegetative or bioengineered methods must be used to stabilize streambanks, unless the Director approves an alternative stabilization method.</p>	E2.25 Pipe Slope Drains E2.30 Subsurface Drains E2.50 Level Spreader E2.55 Interceptor Dike and Swale E2.60 Check Dams E2.70 Outlet Protection E2.75 Riprap E2.80 Vegetative Streambank Stabilization E2.85 Bioengineered Streambank Stabilization E2.90 Structural Streambank Stabilization

Table 1. Construction Stormwater Control Selection (continued)

Requirement	Control Selection Process	Stormwater Control
7. Whenever construction vehicle access routes intersect paved roads, the transport of sediment onto the paved road shall be minimized. If sediment is transported onto a paved road surface, the roads shall be cleaned thoroughly at the end of each day. Sediment shall be removed from paved roads by shoveling or sweeping and shall be transported to a controlled sediment disposal area. Street washing shall be allowed only after sediment is removed in this manner.	The responsible party must stabilize construction entrances and construction roads.	E2.10 Stabilization Construction Entrance E2.15 Construction Road Stabilization
8. All temporary erosion and sediment controls shall be removed within 30 days after final site stabilization is achieved or after the temporary controls are no longer needed, whichever is later. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.	NA—This requirement does not specify which control must be used, but when the controls must be removed.	NA
9. When dewatering devices discharge on site or to a public drainage control system, dewatering devices shall discharge into a sediment trap or sediment pond or gently sloping vegetated area.	NA—This requirement does not specify which control must be used, but how the controls must function.	NA
10. In the construction of underground utility lines, where feasible, no more than 500 feet of trench shall be opened at one time, unless soil is replaced within the same working day, and where consistent with safety and space considerations, excavated material shall be placed on the uphill side of trenches. Trench dewatering devices shall discharge into a sediment trap or sediment pond.	NA—This requirement does not specify which control must be used, but how the controls must function.	NA



Chapter Three

Standards and Specifications for Construction Erosion and Sedimentation Control BMPs

Best Management Practices (BMPs) are defined as physical, structural and/or managerial practices that—when used singly or in combination—prevent or reduce pollution of water and have been approved by Ecology. This chapter contains the standards and specifications for erosion and sediment control BMPs that form the backbone of any Erosion and Sediment Control Plan.

Standards and Specifications for Cover Practices

Specifications and design criteria of BMPs for erosion and sedimentation control can be broadly divided into two categories: 1) cover practices (such as seeding and mulching) and 2) structural practices (such as sediment ponds, filter fences, etc.) that require engineering standards and specifications. Structural control BMPs are explained in the next section.

Vegetative cover is the most important form of erosion control possible because it prevents or reduces erosion rather than attempting to trap sediment after soil has eroded. In addition, it adds to the aesthetic and functional value of a development.

Cover practices can be divided into temporary and permanent measures. Temporary measures are implemented to provide a quick cover to soils that are exposed for longer than 2 to 7 days, or if an erosion problem already exists on the site during the development phase. These measures are shown on the next two pages as Unified Coding Symbols. They include:

- seeding
- mulching and matting
- clear plastic covering

Permanent measures are implemented both during and on completion of construction activities. They include:

- preserving natural vegetation
- buffer zones
- permanent seeding and planting
- sodding

Unified Coding Symbols



BMPs	CODE	SYMBOL	P R O B L E M A R E A S						
			Slope Protection	Waterway Protection	Surface Protection	Enclosed Drainage	Large Flat Areas	Borrow Areas	Adjacent Properties
I. COVER PRACTICES									
E1.10 Temporary Seeding	TS		◆		◆		◆	◆	◆
E1.15 Mulching & Matting	MU		◆				◆	◆	
E1.20 Clear Plastic Covering	CPC		◆					◆	
E1.25 Preserving Natural Vegetation	VEG		◆	◆					
E1.30 Buffer Zones	BZ		◆	◆					◆
E1.35 Permanent Seeding & Planting	PS		◆				◆		
E1.40 Sodding	SO		◆		◆		◆	◆	◆
E1.45 Topsoiling	TO		◆				◆	◆	
II. EROSION CONTROL									
E2.10 Stabilized Construction Entrance & Tire Wash	CE							◆	
E2.15 Construction Road Stabilization	CRS		◆						
E2.20 Dust Control	DC						◆	◆	◆
E2.25 Pipe Slope Drains	PSD		◆						
E2.30 Subsurface Drains	SD		◆						
E2.35 Surface Roughening	SR		◆				◆		
E2.40 Gradient Terraces	GT		◆					◆	

Unified Coding Symbols

BMPs	CODE	SYMBOL	P R O B L E M A R E A S						
			Slope Protection	Waterway Protection	Surface Protection	Enclosed Drainage	Large Flat Areas	Borrow Areas	Adjacent Properties
E2.45 Bioengineered Protection of Very Steep Slopes	SSP		◆					◆	
E2.50 Level Spreader	LS				◆				
E2.55 Interceptor Dike & Swale	IDS		◆					◆	◆
E2.60 Check Dams	CD				◆				◆
E2.70 Outlet Protection	OP			◆	◆				
E2.75 Riprap	RR		◆	◆	◆				
E2.80 Vegetative Streambank Stabilization	VSS			◆					
E2.85 Bioengineering Methods of Streambank Stabilization	BSS			◆					
E2.90 Structural Streambank Protection	SSS			◆					
III. SEDIMENT DETECTION									
E3.10 Filter Fence	FF			◆		◆			◆
E3.15 Straw Bale Barrier	STB			◆		◆			◆
E3.20 Brush Barrier	BB		◆	◆					◆
E3.25 Gravel Filter Berm	GFB		◆	◆			◆		◆
E3.30 Storm Drain Inlet Protection	IP		◆			◆			◆
E3.35 Sediment Trap (or Sump)	ST			◆	◆				◆
E3.40 Sediment Pond (or Basin)	SB			◆	◆	◆			◆

Temporary Cover Practices

BMP E1.10: Temporary Seeding of Stripped Areas

Code	Symbol
	

Definition:

The establishment of a temporary vegetative cover on disturbed areas by seeding with appropriate rapidly growing annual plants.

Purpose

To provide temporary soil stabilization by planting grasses and legumes to areas that would remain bare for more than 7 days where permanent cover is not necessary or appropriate.

Conditions Where Practice Applies

- Permanent structures are to be installed or extensive re-grading of the area will occur prior to the establishment of permanent vegetation.
- Areas, which will not be subjected to heavy, wear by construction traffic.
- Areas sloping up to 10% for 100 feet or less (where temporary seeding is the only BMP used).

Advantages

- This is a relatively inexpensive form of erosion control but should only be used on sites awaiting permanent planting or grading. Those sites should have permanent measures used (see BMP E1.35, Permanent Seeding and Planting).
- Vegetation will not only prevent erosion from occurring, but will also trap sediment in runoff from other parts of the site.
- Temporary seeding offers fairly rapid protection to exposed areas.

Disadvantages/Problems

- Temporary seeding is only viable when there is a sufficient window in time for plants to grow and establish cover. During the establishment period the bare soil should be protected with mulch (see BMP E1.15) and/or clear plastic covering (see BMP E1.20).
- If sown on subsoil, growth will be poor unless heavily fertilized and limed. Because over-fertilization can cause pollution of stormwater runoff, other practices such as mulching (BMP E1.15) alone may be more appropriate. The potential for over-fertilization is an even worse problem in or near aquatic systems.
- Once seeded, areas cannot be used for heavy traffic.
- May require regular irrigation to flourish. Regular irrigation is not encouraged because of the expense and the potential for erosion in areas that are not regularly inspected. The use of low maintenance native species should be encouraged, and planting should be timed to minimize the need for irrigation.

Planning Considerations

Sheet erosion, caused by the impact of rain on bare soil, is the source of most fine particles in sediment. To reduce this sediment load in runoff, the soil surface itself should be protected. The most efficient and economical means of controlling sheet and rill erosion is to establish vegetative cover. Annual plants that sprout rapidly and survive for only one growing season are suitable for establishing temporary vegetative cover. Temporary seeding is effective when combined with construction phasing so that bare areas of the site are minimized at all times.

Temporary seeding may prevent costly maintenance operations on other erosion control systems. For example, sediment basin clean-outs will be reduced if the drainage area of a basin is seeded where grading and construction are not taking place. Perimeter dikes will be more effective if not choked with sediment.

Temporary seeding is essential to preserve the integrity of earthen structures used to control sediment, such as dikes, diversions, and the banks and dams of sediment basins.

Proper seedbed preparation and the use of quality seed are important in this practice just as in permanent seeding. Failure to carefully follow sound agronomic recommendations will often result in an inadequate stand of vegetation that provides little or no erosion control.

Design Criteria

- **Time of Planting** - Planting should preferably be done between April 1 and June 30, and September 1 through October 31. If planting is done in the months of July and August, irrigation may be required. If planting is done between November 1 and March 31, mulching shall be required immediately after planting. If seeding is done during the summer months, irrigation of some sort will probably be necessary.
- **Site Preparation** - Before seeding, install needed surface runoff control measures such as gradient terraces, interceptor dike/swales, level spreaders, and sediment basins.
- **Seedbed Preparation** - The seedbed should be firm with a fairly fine surface. Perform all cultural operations across or at right angles to the slope. See BMP E1.45, Topsoiling, and BMP E2.35, Surface Roughening for more information on seedbed preparation. A minimum of 2 to 4 inches of tilled topsoil is required.
- **Fertilization** - as per suppliers and/or Soil Conservation Service recommendations. Developments adjacent to water bodies must use non-phosphorus fertilizer.
- **Seeding** - seeding mixtures will vary depending on the exact location, soil type, slope, etc. Information on mixes may be obtained from local suppliers, the Washington State Department of Transportation, or the Soil Conservation Service. The seed mix on the following table is supplied as guidance.

Table 2: Seeding Mixtures*



Name	Proportions by Weight	% Purity	% Germination
Redtop (<i>Agrostis alba</i>)	10%	92	90
Annual Rye (<i>Lolium multiflorum</i>)	40%	98	90
Chewings Fescue (<i>Festuca rubra commutata</i>)	40%	97	80
White Dutch Clover (<i>Trifolium repens</i>)	40%	96	90

*"Hydro-seeding" applications with approved seed-mulch-fertilizer mixtures may also be used.

Maintenance

- Seeding should be supplied with adequate moisture. Supply water as needed, especially in abnormally hot or dry weather or on adverse sites. Water application rates should be controlled to prevent runoff.
- Re-seeding - Areas which fail to establish vegetative cover adequate to prevent erosion shall be re-seeded as soon as such areas are identified.
- All temporary erosion and sediment control measures should be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment must be removed or stabilized on site. Disturbed soil areas resulting from removal should be permanently stabilized.

BMP E1.15: Mulching and Matting

Code	Symbol
	

Definition

Application of plant residues or other suitable materials to the soil surface.

Purpose

To provide immediate protection to exposed soils during the period of short construction delays, or over winter months through the application of plant residues, or other suitable materials, to exposed soil areas.

Mulches also enhance plant establishment by conserving moisture and moderating soil temperatures. Mulch helps hold fertilizer, seed, and topsoil in place in the presence of wind, rain, and runoff and maintains moisture near the soil surface.

Conditions Where Practice Applies

- In areas that have been seeded either for temporary or permanent cover, mulching should immediately follow seeding.
- Areas that cannot be seeded because of the season, or are otherwise unfavorable for plant growth.
- Areas that have been seeded as specified in Temporary Seeding (BMP E1.10).
- In an area of greater than 2:1 slope, mulching should immediately follow seeding.

Advantages

- Mulching offers instant protection to exposed areas.
- Mulches conserve moisture and reduce the need for irrigation.
- Neither mulching nor matting requires removal; seeds can grow through them unlike plastic coverings.

Disadvantages/Problems

- Care must be taken to apply mulch at the specified thickness, and on steep slopes mulch must be supplemented with netting.
- Thick mulches can reduce the soil temperature, delaying seed germination.
- Mulches such as straw, which are often applied to areas after grading must then be removed and either composted or landfilled. Straw is hollow, so it can actually draw water into the ground below it if the straw is at an angle.

Planning Considerations

Mulches are applied to the soil surface to conserve a desirable soil property or to promote plant growth. A surface mulch is one of the most effective means of controlling runoff and erosion on disturbed land (see Figure 3 for a comparison of pollutant loading reductions for various mulches).

Mulches can increase the infiltration rate of the soil, reduce soil moisture loss by evaporation, prevent crusting and sealing of the soil surface, modify soil temperatures, and provide a suitable microclimate for seed germination.

Organic mulch materials, such as straw, wood chips, bark, and wood fiber, have been found to be the most effective.

A variety of nets and mats have been developed for erosion control in recent years, and these are also used as mulches, particularly in critical areas such as waterways. They may be used to hold other mulches to the soil surface.

The choice of materials for mulching will be based on the type of soil to be protected, site conditions, season, and economics. It is especially important to mulch liberally in mid-summer and prior to winter, and on cut slopes and southern slope exposures. Table 3 gives a comparison of costs based on 1988 figures.

Organic Mulches

Straw - Straw is the mulch most commonly used in conjunction with seeding. Its use is recommended where immediate protection is desired and preferably where the need for protection will be less than 3 months. The straw should come from wheat or oats, and may be spread by hand or machine. If the straw is not clean, weed growth can occur. Straw can be windblown and must be anchored down. Common anchoring methods are:

1. Crimping, disking, rolling or punching into the soil;
2. Covering with netting;
3. Spraying with a chemical or fiber binder (tackifier); and
4. Keeping moist. Natural precipitation can often provide sufficient moisture.(2)

Corn Stalks - These should be shredded into 4 to 6-inch lengths. Stalks decompose slowly and are resistant to windblow.

Wood Chips - Suitable for areas that will not be closely mowed, and around ornamental plantings. Chips decompose slowly and do not require tacking. They must be treated with 12 pounds nitrogen per ton to prevent nutrient deficiency in plants. Chips can be a very inexpensive mulch if obtained from trees cleared on site. However, both wood and bark chips tend to wash down slopes of more than 6% and create problems by clogging inlet grates etc. and are therefore not preferred for use in those areas.

Bark Chips, Shredded Bark - By-products of timber processing. Used in landscaped plantings. Bark is also a suitable mulch for areas planted to grasses and not closely mowed; may be applied by hand or mechanically. Bark is not usually toxic to grasses or legumes, and additional nitrogen fertilizer is not required.

Wood Fiber - Used in hydroseeding operations, applied as part of the slurry. These short cellulose fibers do not require tacking, although a tacking agent or soil binders are sometimes used with wood fiber. Longer wood fiber works better in erosion control. This form of mulch does not provide sufficient protection to erodible soils to be used alone during severe summer heat or for late fall seedings. Wood fiber hydro-seed slurries may be used to tack straw mulch. This combination treatment is well suited for steep slopes and critical areas, and severe climate conditions.

Other organic materials make excellent mulches but are available only locally or seasonally. Creative use of these materials can reduce costs.

Manure Mulches - Manure mulches should be well-aged and are not recommended for use near waterbodies.

Chemical Mulches and Soil Binders

The use of synthetic, spray-on materials (except tacking agents used with hydro-seeding) is not recommended because they can create impervious surfaces and, possibly, adverse effects on water quality. Research shows that they can cause more erosion when used than does bare exposed soil.

Nets and Mats - Used alone, netting does not retain soil moisture or modify soil temperature. It stabilizes the soil surface while grasses are being established, and is useful in grassed waterways and on slopes. Light netting may also be used to hold other mulches in place. Its relatively high cost makes it most suitable for small sites.

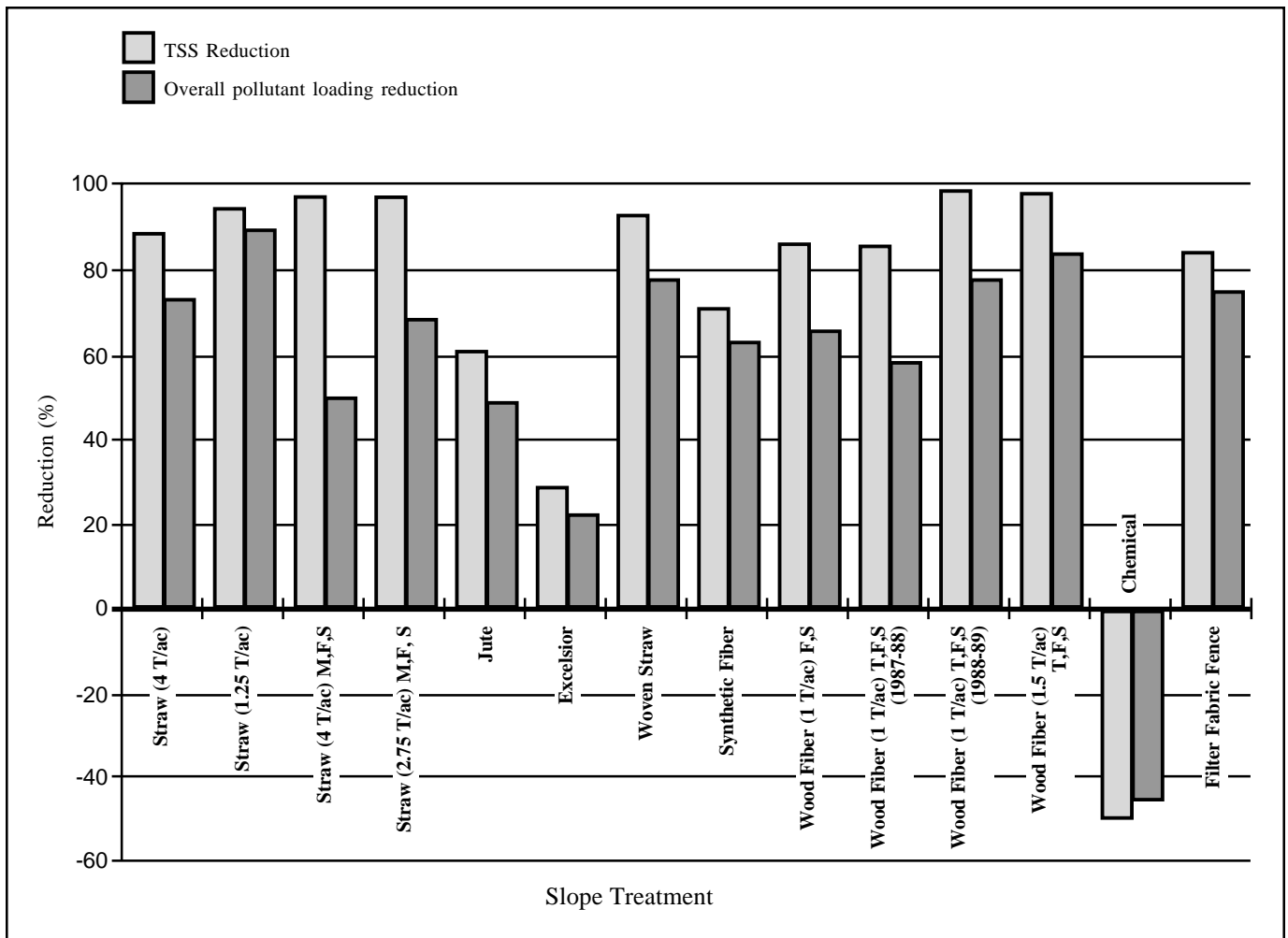
The most critical part of installing nets and mats is obtaining firm, continuous contact between material and soil. Without such contact, the material is useless and erosion occurs. It is important to use an adequate number of staples and to roll the material after laying it to ensure soil is protected.

Table 3. Summary of Estimated Service Lives and Costs 1988 Base¹

Technique ²	Estimated Service Life (months)	Estimated Cost (\$/acre served) (6 months service)
Straw (4 T/ac)	3	3,200
Straw (1.25 T/ac)	3	2,500
Straw (4 T/ac) manure-mulched, fertilized, seeded	6	2,400
Jute mat	6	3,700
Excelsior	6	3,600
Woven straw blanket	6	4,100
Synthetic fiber blanket	6	3,300
Wood fiber mulch (1.25 T/ac) with tackifier (50gal/ac), fertilized, seeded	6	1,300
Wood fiber mulch (1.25 T/ac) with tackifier (90gal/ac), fertilized, seeded	6	2,100
Wood fiber mulch (1.25 T/ac) with tackifier (120gal/ac), fertilized, seeded	6	2,300
Chemical agent	6	2,100
Plastic sheeting	6	2,300
Designed sedimentation pond	>6	<4,200
Non-designed sedimentation pond	>6	<7,500

¹Source: Horner, January 1990

²The estimated cost of seeding where it was used is based on hydroseeding (approximately \$500/acre)

Figure 3. Mean TSS and Overall Pollutant Loading Reductions of Slope Treatments Relative to Controls (Homer 1990)**Design Criteria**

- Site Preparation - Same as Temporary Seeding.
- Mulch Materials, Application Rates, and Specifications - See Table 3.
- Erosion blankets (nets and mats) may be used on level areas, on slopes up to 50%, and in waterways. Where soil is highly erodible, nets shall only be used in connection with organic mulch such as straw and wood fiber. Jute nets shall be heavy, uniform cloth woven of single jute yarn, which if 36 to 48 inches wide shall weigh an average of 1.2 lbs./linear yard. It must be so applied that it is in complete contact with the soil. If it is not, erosion will occur beneath it. Netting shall be securely anchored to the soil with No. 11 gauge wire staples at least 6 inches long, with an overlap of three inches.
- Excelsior blankets are considered protective mulches and may be used alone on erodible soils and during all times of year.
- See Figure 4 for orientation of netting and matting.

Maintenance

- Mulched areas should be checked periodically, especially following severe storms, when damaged areas of mulch or tie-down material should be repaired.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

References

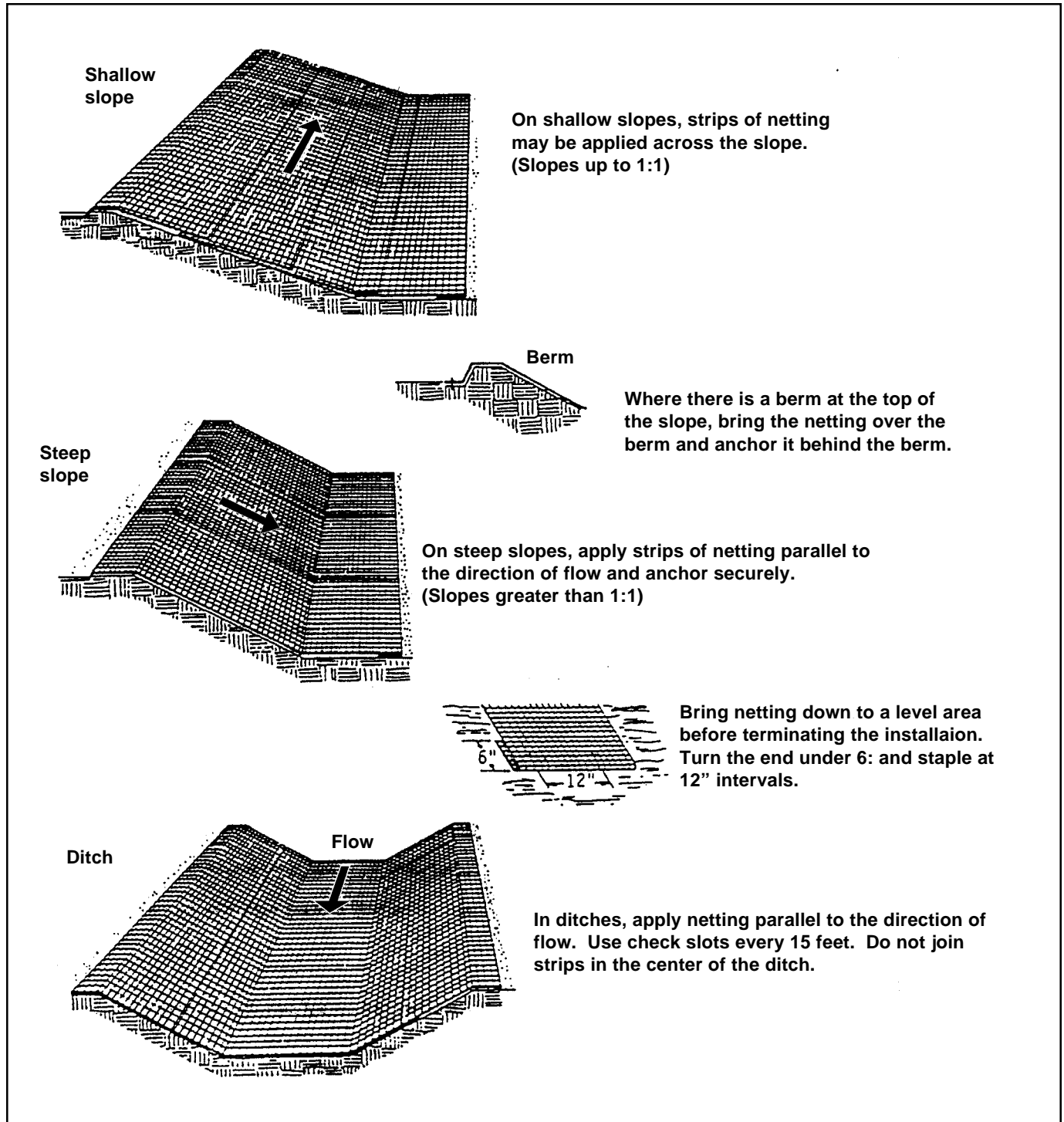
Horner, Richard R., Juno Guedry and Michael H. Korten Hof, Improving the Cost Effectiveness of Highway Construction Site Erosion and Pollution Control, Washington State Dept. of Transportation, WA-RD 200.1, January, 1990.

Table 3. Guide to Mulch Materials, Rates and Uses



Mulch Material	Quality Standards	Application Rates		Application Depth	Remarks ¹
		per 1000 ft ²	per acre		
Gravel, slag or crushed stone	Washed, 0.75 to 1.5" size	9 yds ³		3"	Excellent mulch for short slopes and around woody plants & ornamentals. Use where subject to foot traffic. Approx. 2000 lbs/yd ³
Straw	Air dried Free from unwanted seeds & coarse material	75-100 lbs. 2 - 3 bales	1.5-2.5 tons 90-120 bales	Minimum 2"	Use where mulching effect is to be maintained for >3 months. Is subject to wind blowing unless kept moist or tacked down. Most common & widely used mulching material. Can be used in critical erosion areas.
Wood fiber Cellulose (partially digested wood fibers)	Dyed green. Should not contain growth-inhibiting factors.	25 to 30 1000 to 1500 lbs.			If used on critical areas, double normal application rate. Apply w/hydromulcher. No tie-down required. Packaged in 100 lb. bags.

¹All mulches will provide some degree of (1) erosion control, (2) moisture conservation, (3) weed control, and (4) reduction of soil crusting.

Figure 4. Orientation of Matting and Netting



BMP E1.20: Clear Plastic Covering

Code	Symbol
	

Definition

The covering with clear plastic sheeting of bare areas that need immediate protection from erosion.

Purpose

To provide immediate temporary erosion protection to slopes and disturbed areas that cannot be covered by mulching, in particular during the specified seeding periods or as otherwise required by the local government. Clear plastic also is used to protect dis-

turbed areas that must be covered during short periods of inactivity to meet November 1 through March 31 cover requirements. Because of many disadvantages clear plastic covering is the least preferred covering BMP.

Conditions Where Practice Applies

- Disturbed areas that require immediate erosion protection.
- Areas seeded during the time period from November 1 to March 1.
- Note: Plantings at this time require clear plastic covering for germination and protection from heavy rains.)

Advantages

- Clear plastic covering is a good method of protecting bare areas that need immediate cover and for winter plantings.
- May be quickly and easily placed.

Disadvantages/Problems

- There can be problems with vandals and maintenance.
- The sheeting will result in rapid, 100% runoff, which may cause serious erosion problems and/or flooding at the base of slopes unless the runoff is properly intercepted and safely conveyed by a collecting drain. This is strictly a temporary measure, so permanent stabilization is still required.
- It is relatively expensive.
- The plastic may blow away if it is not adequately overlapped and anchored.
- Ultraviolet and possibly visible light can cause some types of plastic to become brittle and easily torn.
- Plastic must be disposed of at a landfill; it is not easily degradable in the environment.
- If plastic is left on too long during the spring it can severely burn any vegetation that has grown under it during cooler periods.

Design Criteria

- Clear plastic sheeting shall have a minimum thickness of 6 mil and shall meet the requirements of WSDOT/APWA Section 9-14.5.
- Covering shall be installed and maintained tightly in place by using sandbags or tires on ropes with a maximum 10 foot grid spacing in all directions. All seams shall be taped or weighted down full length and there shall be at least a 1 to 2 foot overlap of all seams. Seams should then be rolled and staked or tied.
- Covering shall be installed immediately on areas seeded between November 1 to March 1, and remain until vegetation is firmly established.

- When the covering is used on unseeded slopes, it shall be left in place until the next seeding period.
- Sheeting should be toed in at the top of the slope to prevent surface flow beneath the plastic.
- Sheeting should be removed as soon as is possible once vegetation is well grown to prevent burning the vegetation through the plastic sheeting, which acts as a greenhouse.



Maintenance

- Check regularly for rips and places where the plastic may be dislodged. Contact between the plastic and the ground should always be maintained. Any air bubbles found should be removed immediately or the plastic may rip during the next windy period. Re-anchor or replace the plastic as necessary.

All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

Permanent Cover Practices

BMP E1.25: Preserving Natural Vegetation

Code	Symbol
	

Definition

Minimizing exposed soils and consequent erosion by clearing only where construction will occur.

Purpose

To reduce erosion by preserving natural vegetation wherever practicable.

Condition Where Practice Applies

- Natural vegetation should be preserved on steep slopes, near perennial and intermittent watercourses or swales, and on building sites in wooded areas.
- As required by local governments.

Advantages

Preserving natural vegetation will:

- Help reduce soil erosion.
- Beautify an area.
- Save money on landscaping costs.
- Provide areas for wildlife.
- Possibly increase the value of the land.
- Provide buffers and screens against noise.
- Moderate temperature changes.
- Provide shade and cover habitat for surface waters and land. This is especially important where detention ponds drain to salmonid-bearing streams. Increases in water temperature tend to lower the dissolved oxygen available for aquatic life.

Disadvantages/Problems

Saving individual trees can be difficult, and older trees may become a safety hazard. Cottonwood and alder trees are especially prone to blowdown.

Planning Considerations

New development often takes place on tracts of forested land. In fact, building sites are often selected because of the presence of mature trees. However, unless sufficient care is taken and planning done, in the interval between buying the property and completing construction much of this resource is likely to be destroyed. The property owner is ultimately responsible for protecting as many trees as possible, with their understory and groundcover. It takes 20 to 30 years for newly planted trees to provide the benefits for which we value trees so highly.

Design Criteria

Natural vegetation can be preserved in natural clumps or as individual trees, shrubs and vines.

The preservation of individual plants is more difficult because equipment is generally used to remove unwanted vegetation. The points to remember when attempting to save individual plants are:

- Is the plant worth saving? Consider the location, species, size, age, vigor, and the work involved. Local governments may also have ordinances to save natural vegetation and trees.
- Is the tree or shrub a desirable plant? Is it shallow-rooted, do the roots seek water, or are insects and disease a problem? Shallow-rooted plants can cause problems in the establishment of lawns or ornamental plants. Water-seeking roots can block sewer and tile lines. Insects and diseases can make the plant undesirable. This is especially true with aphid on alder and maple.
- Old and/or large plants do not generally adapt to changes in environment as readily as young plants of the same species. Usually, it is best to leave trees that are less than 40 years of age. Some of the hardwoods (Red alder, Cherry, etc.) mature at approximately 50 years of age. After maturity they rapidly decline in vigor. Conifers, after 40 years of age, may become a safety hazard due to the possibility of breakage or blowdown, especially where construction has left only a few scattered trees in an area that was formerly dense woods. While old large trees are sometimes desirable, the problem of later removal should be considered. Again, local governments may have requirements to preserve older, larger specimen trees. It is expensive to cut a large tree and to remove the tree and stump from a developed area. Thinning some branches from trees can provide avenues for wind and hence lessen the “sail” effect.
- Clearly flag or mark areas around trees that are to be saved. It is preferable to keep ground disturbance away from the trees at least as far out as the dripline.

Plants need protection from three kinds of injuries:

- **Construction Equipment** — This injury can be above or below the ground level. Damage results from scarring, cutting of roots, and compaction of the soil. Roping or fencing a buffer zone around plants to be saved can prevent such injuries. (Figure 5).
- **Grade Changes** — Changing the natural ground level will alter grades, which affect the plant’s ability to obtain the necessary air, water, and minerals. Minor fills usually do not cause problems although sensitivity between species does vary. Cedars are more sensitive. Trees can tolerate fill of 6 inches or less. For shrubs and other plants the fill should be less. When there are major changes in grade, it may become necessary to supply air to the roots of plants. Placing a layer of gravel and a tile system over the roots before the fill is made can do this. A tile system protects a tree from a raised grade.

The tile system should be laid out on the original grade leading from a dry well around the tree trunk. The system should then be covered with small stones to allow air to circulate over the root area (see Figure 5)

Lowering the natural ground level can seriously damage trees and shrubs. The highest percentage of the plant roots are in the upper 12 inches of the soil and cuts of only 2-3 inches can cause serious injury. To protect the roots it may be necessary to terrace the immediate area around the plants to be saved. If roots are exposed, construction of retaining walls may be needed to keep the soil in place. Leaving them on an undisturbed, gently sloping mound can also preserve plants. To increase the chances for survival, it is best to limit grade changes and other soil disturbances to areas outside the dripline of the plant (Figure 5).

- **Excavations** — Protect trees and other plants when excavating for tile, water, and sewer lines. Where possible, the trenches should be routed around trees and large shrubs. When this is not possible, it is best to tunnel under them. This can be done with hand tools or with power augers.

If it is not possible to route the trench around plants to be saved, then the following should be observed:

- Cut as few roots as possible. When you have to cut — cut clean. Paint cut root ends with a wood dressing like asphalt base paint.
- Backfill the trench as soon as possible.
- Tunnel beneath root systems as close to the center of the main trunk to preserve most of the important feeder roots.

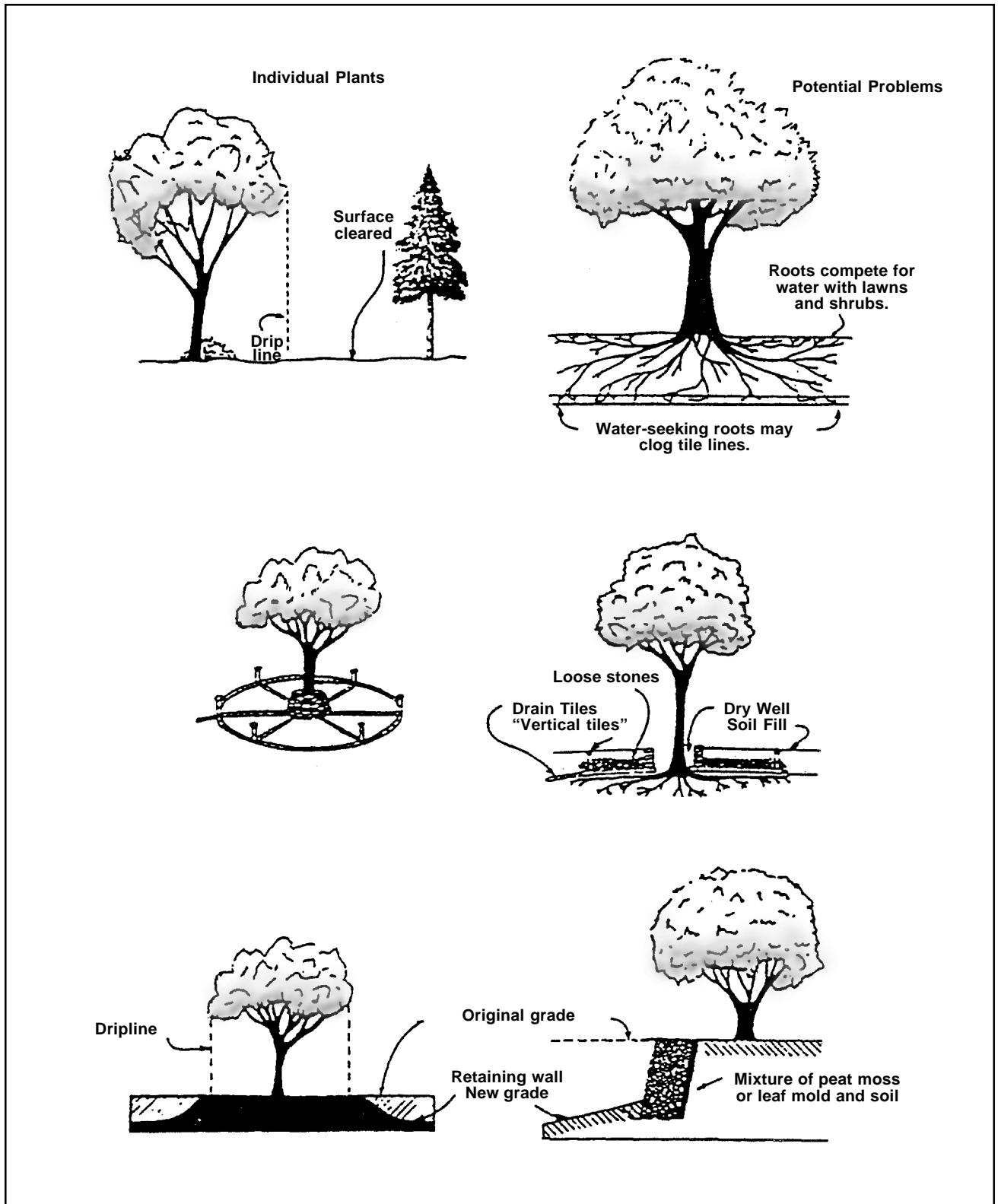
Some problems that can be encountered with a few specific trees are:

- Maple, Dogwood, Red alder, Western hemlock, Western red cedar and Douglas fir do not readily adjust to changes in environment and special care should be taken to protect these trees.
- The tipover hazard of Pacific silver fir is high while that of Western hemlock is moderate. The danger of tipover increases where dense stands have been thinned. Other species (unless they are on shallow, wet soils under 20 inches deep) have a low tipover hazard.
- Cottonwoods, maples, and willows have water-seeking roots. These can cause trouble in sewer lines and filter fields. On the other hand, they thrive in high moisture conditions that other trees would succumb to.
- Thinning operations in pure or mixed stands of Grand fir, Pacific silver fir, Noble fir, Sitka spruce, Western red cedar, Western hemlock, Pacific dogwood, and Red alder can cause serious disease problems. Disease can become established through damaged limbs, trunks, roots, and freshly cut stumps. Diseased and weakened trees are also susceptible to insect attack.



Maintenance

Inspect flagged areas regularly to make sure flagging has not been removed. If tree roots have been exposed or injured, re-cover and/or seal them.

Figure 5. Preserving Natural Vegetation.



BMP E1.30: Buffer Zones

Code	Symbol
	

Definition and Purpose

An undisturbed area or strip of natural vegetation or an established suitable planting that will provide a living filter to reduce soil erosion and runoff velocities.

Conditions Where Practice Applies

Natural buffer zones are used along streams and other bodies of water that need protection from erosion and sedimentation.

Vegetative buffer zones can be used to protect natural swales and incorporated into natural landscaping of an area.

Advantages

- Buffer zones provide critical habitat adjacent to streams and wetlands, as well as assist in controlling erosion, especially on unstable steep slopes. Buffers along streams and other water bodies also provide wildlife corridors, a protected area where wildlife can move from one place to another.
- Act as a visibility and noise screen.

Disadvantages/Problems

- Extensive buffers will increase development costs.

Design Criteria

- Preserving natural vegetation or plantings in clumps, blocks, or strips is generally the easiest and most successful method.
- Leave all unstable steep slopes in natural vegetation.
- Fence or flag clearing limits and keep all equipment and construction debris out of the natural areas.
- Keep all excavations outside the dripline of trees and shrubs.
- Do not push debris or extra soil into the buffer zone area because it will cause damage from burying and smothering.
- Seattle's Environmentally Critical Areas regulations require vegetative buffer zones for all Class A (including Haller Lake and Bitter Lakes) and Class B riparian corridors. Class A riparian corridors require a 50' buffer. Class B riparian corridors require a 25' buffer. The buffer is measured horizontally from the top of bank or ordinary high water mark. (See Table 5 for setback guidelines.)

Seattle's Environmentally Critical Areas (ECA) regulations require the undisturbed vegetative buffer zones from wetlands and riparian corridors (streams and lakes) shown in Table 5:

Table 5. Minimum Recommended Guidelines for Undisturbed Vegetative Setbacks from Wetlands, Streams, Lakes and Other Sensitive/Critical Areas¹

Wetlands	Wetlands of 100 square feet or greater in area require a 50' buffer measured horizontally from the edge of the wetland.
Riparian Corridors	Class A streams and Haller and Bitter Lake require a 50' buffer.
	Class B streams require a 25' buffer.

¹ Expressed in feet from "ordinary high water mark."

NOTE: If ground cover is improved through reseeding,² reduce recommendations to next level within the same category except for excellent rating, which is minimum specification.



Maintenance

- Inspect the area frequently to make sure flagging remains in place and the area remains undisturbed.

¹The term "ordinary high water mark" means the line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank; shelving; changes in the character of soil destruction on terrestrial vegetation, or the presence of litter and debris; or other appropriate means that consider the characteristics of the surrounding area.

²Poor, fair, good and excellent conditions refers to percent coverage and growing condition of vegetation.

BMP E1.35: Permanent Seeding and Planting

Code	Symbol
	

Definition

The establishment of perennial vegetative cover on disturbed areas.

Purpose

To establish permanent vegetation (such as grasses, legumes and trees and shrubs) as rapidly as possible to prevent soil erosion by wind or water, and to improve wildlife habitat and site aesthetics.

To provide pollutant filtration (biofiltration) in vegetation-lined channels and to establish constructed wetlands as required.

Conditions Where Practice Applies

- Graded, final graded or cleared areas where permanent vegetative cover is needed to stabilize the soil.
- Areas that will not be brought to final grade for a year or more.
- Vegetation-lined channels.
- Retention or detention ponds as required.

Advantages

- Well-established grass and ground covers can give an aesthetically pleasing, finished look to a development.
- Once established, the vegetation will serve to prevent erosion and retard the velocity of runoff.

Disadvantages/Problems

- Vegetation and mulch cannot prevent soil slippage and erosion if soil is not inherently stable.
- Coarse, high grasses that are not mowed can create a fire hazard in some locales. Very short mowed grass, however, provides less stability and sediment filtering capacity.
- Grass planted to the edge of a watercourse may encourage fertilizing and mowing near the water's edge and increase nutrient and pesticide contamination.
- May require regular irrigation to establish and maintain.

Planning Considerations

Vegetation controls erosion by reducing the velocity and the volume of overland flow and protecting the bare soil surface from raindrop impact.

Areas that must be stabilized after the land has been disturbed require vegetative cover. The most common and economical means of establishing this cover is by seeding grasses and legumes.

Advantages of seeding over other means of establishing plants include the small initial establishment cost, the wide variety of grasses and legumes available, low labor requirement, and ease of establishment in difficult areas.

Consider the microclimate(s) within the development area. Low areas may be frost pockets and require hardier vegetation since cold air tends to sink and flow towards low spots. South-facing slopes may be more difficult to re-vegetate because they tend to be sunnier and drier.

Disadvantages that must be dealt with are the potential for erosion during the establishment stage, a need to reseed areas that fail to establish, limited periods during the year suitable for seeding, and a need for water and appropriate climatic conditions during germination.

There are so many variables in plant growth that an end product cannot be guaranteed. Much can be done in the planning stages to increase the chances for successful seeding. Selection of the right plant materials for the site, good seedbed preparation, timing, and conscientious maintenance are important. Whenever possible, native species of plants should be used for landscaping. These plants are already adapted to the locale and survivability should be higher than with exotic species.

Native species are also less likely to require irrigation, which can be a large maintenance burden and is neither cost-effective nor ecologically sound.

If non-native plant species are used, they should be tolerant of a large range of growing conditions and as low-maintenance as possible.

Design Criteria

- Vegetation cannot be expected to supply an erosion control cover and prevent slippage on a soil that is not stable due to its texture, structure, water movement, or excessive slope.
- Seeding should be done immediately after final shaping, except during the period of November 1 through March 1, when the site should be protected by mulching or plastic covering until the next seeding period.
- Permanent vegetation may be in the form of grass-type growth by seeding or sodding, or it may be trees or shrubs, or a combination of these. Establishing this cover may require the use of supplemental materials, such as mulch or jute netting (see BMP E1.15).
- **Site Preparation:** Install needed surface runoff control measures such as gradient terraces, berms, dikes, level spreaders, waterways, and sediment basins prior to seeding or planting.
- **Seeding Grasses and Legumes:** Seedbed Preparation — If infertile or coarse textured subsoil will be exposed during land shaping, it is best to stockpile topsoil and respread it over the finished slope at a minimum 2 to 6-inch depth and roll it to provide a firm seedbed. If construction fills have left soil exposed with a loose, rough, or irregular surface, smooth with blade and roll. If cuts or construction equipment have left a tightly compacted surface, break with chisel plow or other suitable implement. Perform all cultural operations across or at right angles to the slope (contoured), such as with cat tracks on the final pass. The seedbed should be firm with a fairly fine surface.
- **Soil Amendments:** Rates will depend on site characteristics and soil, but as a guide, apply lime at the rate of 100 pounds per 1,000 square feet. Apply actual nitrogen at the rate of 1-2 pounds per 1,000 sq. feet, phosphoric acid at the rate of 1.5 pounds per 1,000 sq. feet, and potassium at the rate of 1.5 pounds per 1,000 sq. feet. Work in lime and other nutrients to a depth of a minimum of 4 inches with suitable equipment. Scatter amendments uniformly and work into the soil during seedbed preparation.
- **Seeding:** Apply an appropriate mixture to the prepared seedbed at a rate of 120 lbs/acre. (To take account of local conditions, the local government may vary Seed mixture).

Table 6. Urban and Rural Application of Seeding Mixtures*

Name	Proportions by Weight	% Purity	% Germination
URBAN			
Kentucky Bluegrass	30%	85	80
Creeping Red Fescue	40%	98	90
Perennial Rye	30%	95	90
RURAL			
Kentucky Bluegrass (<i>Poa pratensis</i>)	15%	85	80
Tall Fescue (<i>Festuca arundinacea</i>)	40%	95	90
Perennial Rye (<i>Lolium perenne</i>)	30%	95	90
Chewings Fescue	15%	95	90

Cover the seed with topsoil or mulch no deeper than ½ inch. It is better to work topsoil into the upper soil layer rather than spread a layer of it directly onto the top of the native soil.

“Hydro-seeding” applications with approved seed-mulch-fertilizer mixtures may also be used.

Wetlands Seed Mixtures: For newly created wetlands, a wetlands specialist should design plantings to provide the best chance of success. As a guide apply the following mixture at a rate of 60 lbs/acre, and/or additional tubers for cattail, bulrush, slough sedge, as required by the local government. See Chapter III-4, Volume III for more information on constructed wetlands.

Do not under any circumstances use introduced, invasive plants like reed canary grass (*Phalaris arundinacea*) or purple loosestrife (*Lythrum salicaria*). Using plants such as these will cause many more problems than they will ever solve.

Table 7. Wetlands Seed Mixtures

Name	Proportions by Weight	% Purity	% Germination
Red Top (<i>Agrostis alba</i>)	30%	92	80
Birdsfoot Trefoil (<i>Lotus corniculatus</i>)	30%	90	80
Creeping Red Fescue	40%	98	90

Tree and Shrub Planting

Besides their erosion and sediment control values, trees and shrubs also provide natural beauty and wildlife benefits. When used for the latter, they are usually more effective when planted in clumps or blocks. These procedures should be followed:



1. Trees and shrubs will do best in topsoil. If no topsoil is available, they can be established in subsoil with proper amendment. If trees and shrubs are to be planted in subsoil, particular attention should be paid to amending the soil with generous amounts of organic matter. Mulches should also be used.
2. Good quality planting stock should be used. Normally one or two-year old deciduous seedlings, and three or four-year old coniferous transplants, when properly produced and handled are adequate. Stock should be kept cool and moist from time of receipt and planted as soon as possible.
3. Competing vegetation, if significant, should be pulled out of the area where the plant or plants are to be placed.

Maintenance

Inspect seeded areas for failure and make necessary repairs and reseed immediately. Conduct or follow-up survey after one year and replace failed plants where necessary.

- If vegetative cover is inadequate to prevent rill erosion, overseed and fertilize in accordance with soil test results.
- If a stand has less than 40% cover, reevaluate choice of plant materials and quantities of lime and fertilizer. Re-establish the stand following seedbed preparation and seeding recommendations, omitting lime and fertilizer in the absence of soil test results. If the season prevents resowing, mulch or jute netting is an effective temporary cover.

BMP E1.40: Sodding

Code	Symbol
	

Definition

Stabilizing fine-graded disturbed areas by establishing permanent grass stands with sod.

Purpose

To establish permanent turf for immediate erosion protection or to stabilize drainageways where concentrated overland flow will occur.

Conditions Where Practice Applies

- Disturbed areas which require immediate vegetative cover.
- Waterways carrying intermittent flow, where immediate stabilization or aesthetics are factors and other locations that are particularly suited to stabilization with sod.

Advantages

- Sod will give immediate protection.
- Sod gives an immediate vegetative cover, which is both effective in checking erosion and is aesthetically pleasing.
- Good sod has a high density of growth, which is superior in protection to a recently seeded area.
- Sod can be placed at any time of the year provided that soil moisture is adequate and the ground is not frozen.

Disadvantages/Problems

- Sod is expensive.
- Sod is heavy and handling costs are high.
- Good quality sod, free from weed species, may be difficult to obtain.
- If laid in an unfavorable season, midsummer irrigation may be required. This also applies to very droughty sandy soils.
- Grass species in the sod may not be suitable for site conditions.
- If mowing is required, do not use grass sod on slopes steeper than 3:1 (use minimum maintenance ground covers).
- If not anchored or drained properly, sod will “roll up” in grassed waterways.

Design Criteria



- Shape and smooth the surface to final grade in accordance with the approved grading plan.
- Use of topsoil shall be in accordance with the requirements of Topsoiling (BMP E1.50).
- Add lime to reach a soil pH value of 6.5 (based on soil tests).
- Fertilize according to a soil test or in the absence of a test use available nitrogen, phosphorus and potash as prescribed for permanent seeding. Use fertilizers that are not highly soluble.
- Work lime and fertilizer into the soil 1 to 2 inches deep and smooth the surface.

- Lay strips of sod beginning at the lowest area to be sodded and perpendicular to the direction of water flow. Wedge strips securely in place. Square the ends of each strip to provide for a close, tight fit. Stagger joints at least 12 inches. Staple if on steep slopes.
- Roll the sodded area and irrigate.
- When sodding is carried out in alternating strips, or other patterns, seed the areas between the sod immediately after sodding.
- Sod should be free of weeds and be of uniform thickness (Approx. 1 in.) and should have a dense root mat for mechanical strength.

Maintenance

- Inspect sodded areas regularly, especially after large storm events. Re-tack, re-sod, or re-seed as necessary.

BMP E1.45: Topsoiling

Code	Symbol
	

While not a permanent cover practice in itself, topsoiling has been included in this section because it is an integral component of preparing permanent cover to those areas where there is an unsuitable soil surface for plant growth. Use of in-situ or imported topsoil is always preferable to planting in subsoil.

Definition

Preserving and using topsoil to enhance final site stabilization with vegetation.

Purpose

To provide a suitable growth medium for final site stabilization with vegetation.

Conditions Where Practice Applies

- Preservation or importation of topsoil is determined to be the most effective method of providing a suitable growth medium, and the slopes are less than 2:1.
- Applicable to those areas with highly dense or impermeable soils or areas where planting is to be done in subsoil, where mulch and fertilizer alone would not provide a suitable growth medium.

Advantages

- Topsoil stockpiling ensures that a good growth medium will be available for establishing plant cover on graded areas. It has a high organic matter content and friable consistency, water holding capacity and nutrient content.
- The stockpiles can be used as noise and view baffles during construction.

Disadvantages/Problems

- Stripping, stockpiling, and reapplying topsoil, or importing topsoil may not always be cost-effective. It may also create an erosion problem if improperly secured.
- Unless carefully located, storage banks of topsoil may also obstruct site operations and therefore require double handling.
- Topsoiling can delay seeding or sodding operations, increasing exposure time of denuded areas.
- Most topsoil contains some weed seeds.

Planning Considerations

Topsoil is the surface layer of the soil profile, generally characterized as being darker than the subsoil due to the presence of organic matter. It is the major zone of root development, carrying much of the nutrients available to plants, and supplying a large share of the water used by plants.

Topsoiling is strongly recommended where ornamental plants or high-maintenance turf will be grown. Topsoiling is a required procedure when establishing vegetation on shallow soils, and soils of critically low pH (high acid) levels.

If topsoiling is to be done, the following items should be considered:

1. Whether an adequate volume of topsoil exists on the site. Topsoil should be spread at a depth of 2-4 inches. More topsoil will be needed if the subsoil is rocky.
2. Location of the topsoil stockpile so that it meets specifications and does not interfere with work on the site.

3. Allow sufficient time in scheduling for topsoil to be spread and bonded prior to seeding, sodding, or planting.
4. Care must be taken not to apply to subsoil if the two soils have contrasting textures. Sandy topsoil over clayey subsoil is a particularly poor combination, as water creeps along the junction between the soil layers and causes the topsoil to slough.
5. If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to establish vegetation. The best method to prevent a lack of bonding is to actually work the topsoil into the layer below for a depth of at least 6 inches.

Design Criteria

- Field exploration of the site shall be made to determine if there is surface soil of sufficient quantity and quality to justify stripping. Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, clay loam). Areas of natural ground water recharge should be avoided.
- Stripping shall be confined to the immediate construction area. A 4 to 6 inch stripping depth is common, but depth may vary depending on the particular soil. All surface runoff control structures shall be in place prior to stripping.
- Stockpiling of topsoil shall occur in the following manner:
 - a. Side slopes of the stockpile shall not exceed 2:1.
 - b. An interceptor dike with gravel outlet and silt fence shall surround all topsoil stockpiles.
 - c. Erosion control seeding or covering with clear plastic or other mulching materials (see BMPs E1.10, E1.20) of stockpiles shall be completed within 7 days of the formation of the stockpile.
- Topsoil shall not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed sodding or seeding.
- Previously established grades on the areas to be topsoiled shall be maintained according to the approved plan.

Maintenance

- Cover piles with clear plastic covering until needed.

Standards and Specifications for Structural and Biomechanical Practices

Structural and biomechanical control practices are used to either reduce erosion or retain sediment on the construction site. The BMPs in this section have been divided into two basic groups based on these characteristics. The standards and specifications of each BMP are presented in the same format used for nonstructural practices.

Structural erosion control BMPs include measures for site stabilization (such as stabilized construction entrances), slope protection (such as pipe slope drains) and drainageway protection (such as level spreaders). **Sediment control** BMPs include filter fences, berms, and sediment traps. The Unified Coding Symbols for these and all other BMPs in the volume are located on pages 14 and 15.

Structural control is more effective when combined with vegetative protection and appropriate grading practices as part of an Erosion and Sediment Control (ESC) Plan (see the supplemental guidelines on preparing an ESC plan). Control measures may be either permanent or temporary depending on whether they will remain in use after development is complete.

Although temporary structures are emphasized in this section, they may be combined with permanent control facilities to provide protection of downstream properties during construction. Temporary ESC facilities provide siltation control, but downstream erosion protection must also be provided. Accordingly, the allowable discharge from development sites shall not exceed 0.15 cfs for the 2-year, 24-hour storm.

It is also important not to disturb areas of natural ground water discharge and/or retention. To accomplish this, a permanent detention pond may have to be constructed first with modifications allowing it to temporarily function as a sediment pond. Or, a flow control structure may be required on the outlet of the sediment pond.

The design of structural measures for erosion and sedimentation control is accomplished by carefully predetermining appropriate factors. The design storm, maximum drainage area, slope and other restrictions are noted for each BMP. The design criteria and limitations are important; if they are not observed, the simplest measures will fail and erosion control will not be achieved.

In most ESC designs, especially for sites larger than 5 acres, several small structures will function more effectively than a single large structure. For example, a combination of BMPs, such as filter fences, temporary dikes/swales, and several small sediment traps/ponds (depending on subbasin configuration) may be used as opposed to a single large sediment pond.

Maintenance is also of critical importance for proper operation of structural BMPs and must be considered in their design. Maintenance requirements and frequency vary with each BMP and its performance criteria. At a minimum, the ESC plan shall require monthly maintenance, or following each runoff producing storm (whichever occurs more frequently), for silt removal and proper operation of all ESC facilities. ESC facilities may have to be replaced or relocated depending on their performance under field conditions.

The following factors should be considered when designing structural control measures:



- Use material available on-site whenever possible.
- Keep structures simple and take advantage of permanent facilities unless the permanent structures are for infiltration.

- Install the most important control structures first.
- Install BMPs correctly; visit the site during and after storms to be sure that all structures are properly located, constructed, and functioning as designed.
- Install control measures in sequences that minimize land disturbance. For example, install interceptor dikes/swales and drainage trenches before seeding to avoid disturbing the seedbed. Avoid disturbing or removing existing vegetation whenever possible.
- Do not block a natural drainageway. Make certain that all necessary permits have been obtained before starting any work in a wetland, stream, or other sensitive area.
- Place control measures out of the way of construction operations.
- Make field modifications where necessary with the approval of the local jurisdiction.
- Provide access for maintenance.

Although design and construction standards and specifications are presented in some detail, this section is not a substitute for training in hydraulic and construction engineering. The materials presented are guidelines to assist in the design of erosion control measures. The standards and specifications provided should not be considered rigid requirements except where statutory requirements are indicated. Where local experience has shown that an alternate design will work better, it may be used as long as it meets the requirements contained found in the Stormwater, Grading, and Drainage Control Code. Designers are encouraged to continuously seek out new, more reliable solutions for controlling erosion and sediment.

Structural Erosion Control BMPs

BMP E2.10: Stabilized Construction Entrance and Tire Wash

Code	Symbol
	

Definition

A temporary stone-stabilized pad located at points of vehicular ingress and egress on a construction site.

Purpose

To reduce the amount of mud, dirt, rocks, etc. transported onto public roads by motor vehicles or runoff by constructing a stabilized pad of rock spalls at entrances to construction sites and washing of tires during egress.

Conditions Where Practice Applies

Whenever traffic will be leaving a construction site and moving directly onto a public road or other paved areas.

Advantages

- Mud on vehicle tires is significantly reduced which avoids hazards caused by depositing mud on the public roadway.
- Sediment, which is otherwise contained on the construction site, does not enter stormwater runoff elsewhere.

Planning Considerations

Construction entrances provide an area where mud can be removed from vehicle tires before they enter a public road. If the action of the vehicle traveling over the gravel pad is not sufficient to remove the majority of the mud, then the tires must be washed before the vehicle enters a public road. If washing is used, provisions must be made to intercept the wash water and trap the sediment before it is carried off-site. Construction entrances should be used in conjunction with the stabilization of construction roads to reduce the amount of mud picked up by vehicles.

It is important to note that this BMP will only be effective if sediment control is used throughout the rest of the construction site.

Design Criteria

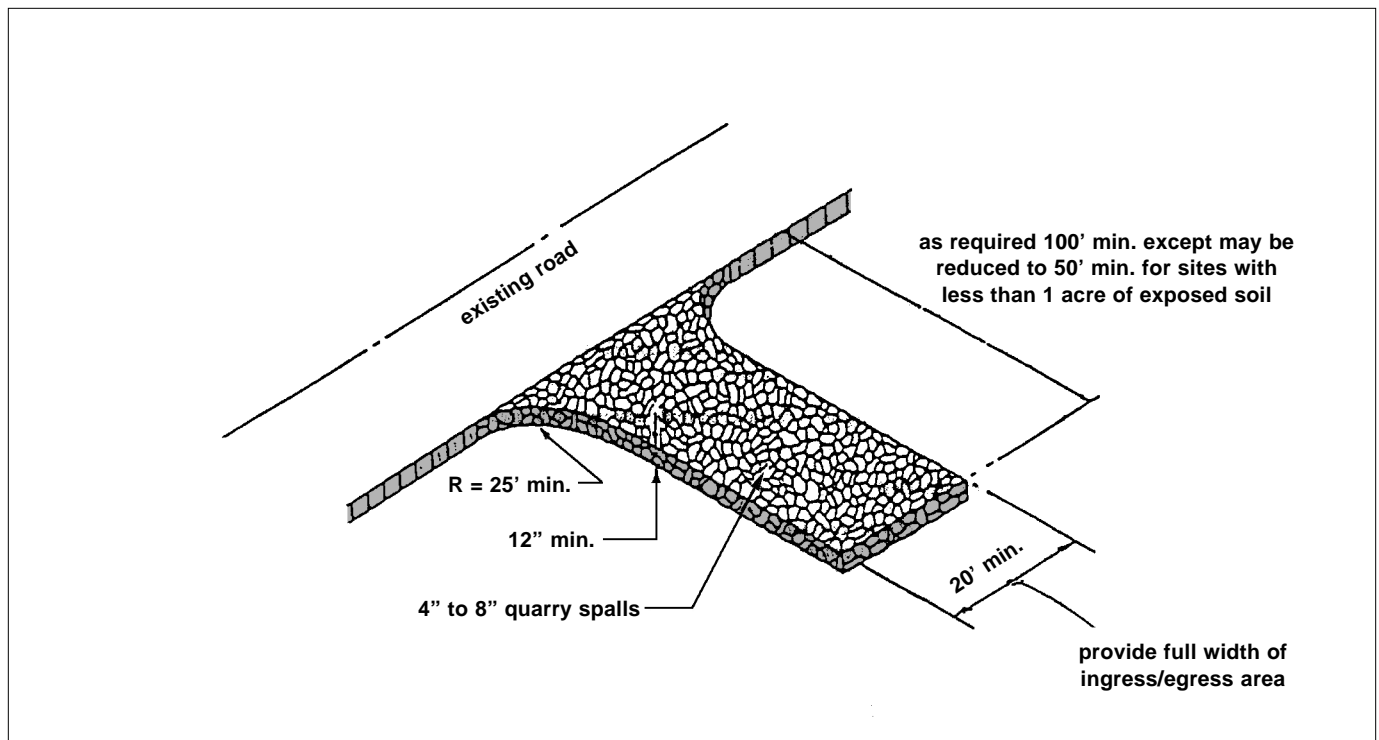
- Material should be quarry spalls (where feasible), 4 inches to 8 inches size.
- The rock pad shall be at least 12 inches thick and 100 feet in length for sites more than 1 acre; and may be reduced to 50 feet in length for sites less than 1 acre.
- A filter fabric fence (see BMP E3.10) should be installed down-gradient from the construction entrance in order to contain any sediment-laden runoff from the entrance.
- Width shall be the full width of the vehicle ingress and egress area (minimum 20 feet).
- Additional rock should be added periodically to maintain proper function of the pad.
- See Figure 6 for details.
- Tire washing should be done before the vehicle enters a paved street. Washing should be done on an area covered with crushed rock and the wash water should be drained to a sediment retention facility such as a sediment trap or basin.

- The volume of wash water produced by tire washing should be included when calculating the sediment trap or basin size.



Maintenance

- The entrance shall be maintained in a condition that will prevent tracking or flow of mud onto public rights-of-way. This may require periodic top dressing with 2-inch stone, as conditions demand, and repair and/or cleanout of any structures used to trap sediment. All materials spilled, dropped, washed, or tracked from vehicles onto roadways or into storm drains must be removed immediately.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

Figure 6. Stabilized Construction Entrance



BMP E2.15: Construction Road Stabilization

Code	Symbol
	

Definition

The temporary stabilization with stone of access roads, subdivision roads, parking areas, and other on-site vehicle transportation routes immediately after grading.

Purpose

- To reduce erosion of temporary road beds by construction traffic during wet weather.
- To reduce the erosion and therefore regrading of permanent road beds between the time of initial grading and final stabilization.

Conditions Where Practice Applies

- Wherever rock-base roads or parking areas are constructed, whether permanent or temporary, for use by construction traffic.
- Note: Exceptions may be granted in areas with gravelly soils, such as the Everett series, as approved by the local government.

Advantages

- Efficiently constructed road stabilization not only reduces on-site erosion but can significantly speed on-site work, avoid instances of immobilized machinery and delivery vehicles, and generally improve site efficiency and working conditions during adverse weather.

Disadvantages/Problems

- Measures on temporary roads must be cheap not only to install but also to demolish if they interfere with the eventual surface treatment of the area.
- Application of aggregate to construction roads may need to be made more than once during a construction period.

Planning Considerations

Areas that are graded for construction vehicle transport and parking purposes are especially susceptible to erosion. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative stabilization. Such areas also tend to collect and transport runoff waters along their surfaces. During wet weather, they often become muddy quagmires that generate significant quantities of sediment that may pollute nearby streams or be transported off-site on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

Immediate stabilization of such areas with stone may cost money at the outset, but it may actually save money in the long run by increasing the usefulness of the road during wet weather.

Permanent roads and parking areas should be paved as soon as possible after grading. As an alternative, the early application of stone may solve potential erosion and stability problems and eliminate later regrading costs. Some of the stone will also probably remain in place for use as part of the final base course of the road.

Design Criteria

- A 6-inch course of 2 to 4-inch crushed rock, gravel base, or crushed surfacing base course shall be applied immediately after grading or the completion of utility installation within the right-of-way. A 4-inch course of asphalt treated base (ATB) may be used in lieu of the crushed rock, or as advised by the local government.
- Where feasible, alternative routes should be made for construction traffic; one for use in dry condition, the other for wet conditions, which incorporate the measures, listed below.
- Temporary roads should follow the contour of the natural terrain to the maximum extent possible. Slope should not exceed 15%. Roadways should be carefully graded to drain transversely. Provide drainage swales on each side of the roadway in the case of a crowned section, or one side in the case of a super-elevated section.
- Installed inlets shall be protected to prevent sediment-laden water entering the drain sewer system (see Storm Drain Inlet Protection BMP E3.30).
- Simple gravel berms without a trench can be used for less traveled roads.



Undisturbed buffer areas should be maintained at all stream crossings.

- Areas adjacent to culvert crossings and steep slopes should be seeded and mulched and/or covered.
- Dust control should be used when necessary (see BMP E2.20).

Maintenance

- Inspect stabilized areas regularly, especially after large storm events. Add crushed rock if necessary and restabilize any areas found to be eroding.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

BMP E2.20: Dust Control

Code	Symbol
	

Definition

Reducing surface and air movement of dust during land disturbing, demolition, and construction activities.

Purpose

To prevent surface and air movement of dust from exposed soil surfaces.

Conditions Where Practice Applies

In areas (including roadways) subject to surface and air movement of dust where on-site and off-site damage is likely to occur if preventive measures are not taken.

Advantages

- A decrease in the amount of dust in the air will decrease the potential for accidents and respiratory problems.

Disadvantages/Problems

- Use of water on-site to control dust emissions, particularly in areas where the soil is already compacted, can cause a runoff problem where there wasn't one.

Planning Considerations

Construction activities inevitably result in the exposure and disturbance of soil. Fugitive dust is emitted both during the activities (i.e., excavation, demolition, vehicle traffic, human activity) and as a result of wind erosion over the exposed earth surfaces. Large quantities of dust are typically generated in “heavy” construction activities, such as road and street construction and subdivision, commercial and industrial development, which involve disturbance of significant areas of soil surface. Research at construction sites has established an average dust emission rate of 1.2 tons/acre/month for active construction. Earthmoving activities are the major source, but traffic and general disturbance of the soil also generate significant dust emissions.

In planning for dust control, remember that the less soil is exposed at any one time, the less potential there will be for dust generation. Therefore, phasing a project and utilizing temporary stabilization practices upon the completion of grading can significantly reduce dust emissions.



Design Criteria

- Minimize the period of soil exposure through use of temporary ground cover and other temporary stabilization practices (see Seeding and Mulching, BMPs E1.10 and E1.15).
- Sprinkle the site with water until surface is wet. Repeat as needed. To prevent carryout of mud onto street, refer to Stabilized Construction Entrance (BMP E2.10).
- Spray exposed soil areas with approved dust palliative. Oil should not be used for dust suppression. Check with local agencies to determine other dust palliatives that may be used.

Maintenance

- Respray area as necessary to keep dust to a minimum.

BMP E2.25: Pipe Slope Drains

Code	Symbol
	

Definition

A pipe extending from the top to the bottom of a cut or fill slope and discharging into a stabilized watercourse or a sediment trapping device or onto a stabilization area.

Purpose

To carry concentrated runoff down steep slopes without causing gullies, channel erosion, or saturation of slide-prone soils.

Conditions Where Practice Applies

Where a temporary (or permanent) measure is needed for conveying runoff down a slope without causing erosion.

Advantages

Slope drains provide a potentially effective method of conveying water safely down steep slopes.

Disadvantages/Problems

Care must be taken to correctly site drains and not under design them. Also, when clearing takes place prior to installing these drains, care must be taken to revegetate the entire easement area, otherwise erosion tends to occur beneath the pipeline, resulting in gully formation.

Planning Considerations

There is often a significant lag between the time a cut or fill slope is completed and the time a permanent drainage system can be installed. During this period, the slope is usually not stabilized and is particularly vulnerable to erosion. This situation also occurs on slope construction that is temporarily delayed before final grade is reached. Temporary slope drains can provide valuable protection of exposed slopes until permanent drainage structures can be installed. When used in conjunction with diversion dikes, temporary slope drains can be used to convey stormwater from the entire drainage area above a slope to the base of the slope without erosion. It is very important that these temporary structures be installed properly since their failure will often result in severe gully erosion. The entrance section must be securely entrenched, all connections must be watertight, and the conduit must be staked securely.

Design Criteria

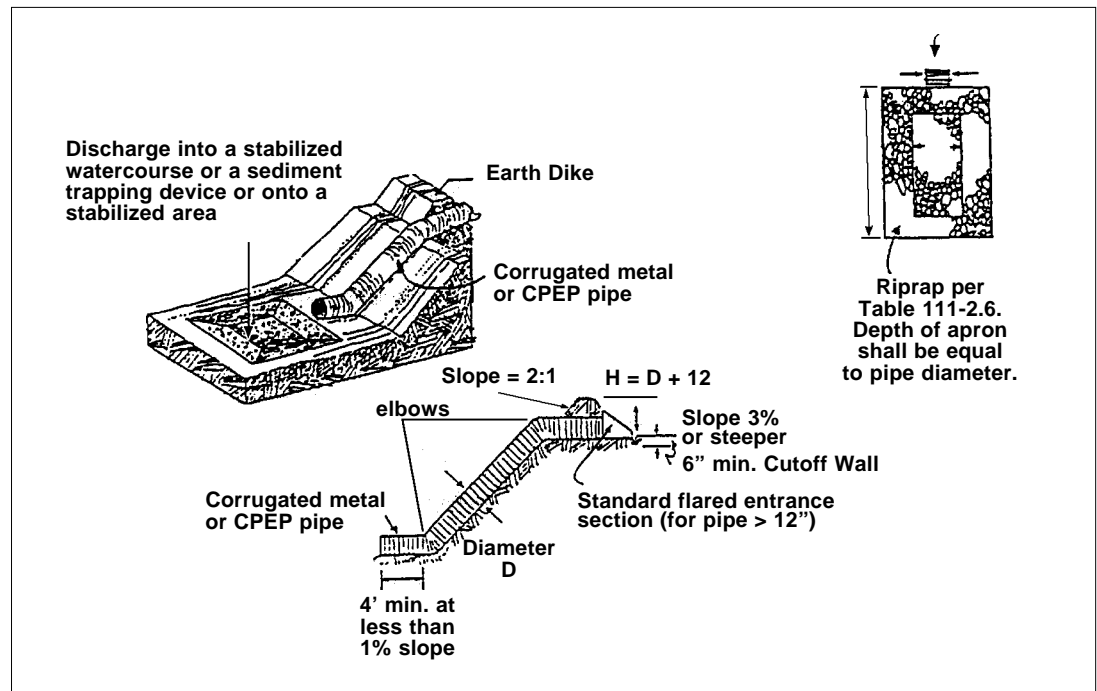
- The capacity for temporary drains shall be sufficient to handle a 10-year, 24-hour peak flow. Permanent pipe slope drains shall be sized for the 25-year 24-hour peak flow.
- The maximum drainage area allowed per pipe is ten acres. For larger areas, a rock-lined channel or more than one pipe shall be installed.
- The entrance shall consist of a standard flared end section for culverts 12 inches and larger with a minimum 6-inch metal toe plate to prevent runoff from undercutting the pipe inlet. The slope of the entrance shall be at least 3% (Figure 8).
- The soil around and under the pipe and entrance section shall be thoroughly compacted to prevent undercutting.
- The flared inlet section shall be securely connected to the slope drain and have watertight connecting bands.
- Slope drain sections shall be securely fastened together and have gasketed watertight fittings, and be securely anchored into the soil.

- Interceptor dikes shall be used to direct runoff into a slope drain. The height of the dike shall be at least 1 foot higher at all points than the top of the inlet pipe.
- The area below the outlet must be stabilized with a riprap apron (see BMP E2.70, Outlet Protection, for the appropriate outlet material).
- If the pipe slope drain is conveying sediment-laden water, direct all flows into the sediment trapping facility.
- The local government shall set materials specifications for the type of pipe used.



Maintenance

- Check inlet and outlet points regularly, especially after heavy storms. The inlet should be free of undercutting, and no water should be going around the point of entry. If there are problems, reinforce the headwall with compacted earth or sand bags. The outlet point should be free of erosion and installed with appropriate outlet protection (see BMP E2.70).
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

Figure 7. Pipe Slope Drains



BMP E2.30: Subsurface Drains

Code	Symbol
	

Definition

A perforated conduit such as a pipe, tubing, or tile installed beneath the ground to intercept and convey ground water.

Purpose

To provide a dewatering mechanism for draining excessively wet, sloping soils—usually consisting of an underground-perforated pipe that will intercept and convey ground water.

Conditions When Practice Applies

- Wherever excessive water must be removed from the soil. The soil must be deep and permeable enough to allow an effective system to be installed.

Advantages

- Subsurface drains often provide the only practical method of stabilizing excessively wet, sloping soils.

Disadvantages/Problems

- Problems may be encountered with tree roots (see Maintenance).
- Pipes cannot be located under heavy vehicle crossings.

Planning Considerations

Subsurface drainage systems are of two types; relief drains and interceptor drains. Relief drains are used either to lower the water table in order to improve the growth of vegetation, or to remove surface water. They are installed along a slope and drain in the direction of the slope. They can be installed in a gridiron pattern, a herringbone pattern, or a random pattern (Figure 8).

Interceptor drains are used to remove water as it seeps down a slope to prevent the soil from becoming saturated and subject to slippage. They are installed across a slope and drain to the side of the slope. They usually consist of a single pipe or series of single pipes instead of a patterned layout (Figure 9).

Design Criteria

- Subsurface drain shall be sized for the required capacity. The minimum diameter for a subsurface drain shall be four inches.
- The minimum velocity required to prevent silting is 1.4 ft./sec. The line shall be graded to achieve at least this velocity.
- Filter material and fabric shall be used around all drains for proper bedding and filtration of fine materials.
- The outlet of the subsurface drain shall empty into a sediment trap or pond. If free of sediment, it shall empty into a receiving channel, swale, or stable vegetated area adequately protected from erosion and undermining.
- The strength and durability of the pipe shall meet the requirements of the site in accordance with the manufacturer's specifications.

Construction Specifications

- The trench shall be constructed on a continuous grade with no reverse grades or low spots.
- Soft or yielding soils under the drain shall be stabilized with gravel or other suitable material.

- Deformed, warped, or otherwise unsuitable pipe shall not be used.
- Filter material shall be placed as specified with at least 3 inches of material on all sides of the pipe.
- Backfilling shall be done immediately after placement of the pipe. No sections of pipe shall remain uncovered overnight or during a rainstorm. Backfill material shall be placed in the trench in such a manner that the drainpipe is not displaced or damaged.

Maintenance

- Subsurface drains shall be checked periodically to ensure that they are free-flowing and not clogged with sediment.
- The outlet shall be kept clean and free of debris.
- Surface inlets shall be kept open and free of sediment and other debris.
- Trees located too close to a subsurface drain often clog the system with their roots. If a drain becomes clogged, relocate the drain or remove the trees as a last resort. Drain placement should be planned to minimize this problem.
- Where heavy vehicles cross drains, the line shall be checked to ensure that it is not crushed.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

Figure 8. Subsurface Drain Layout

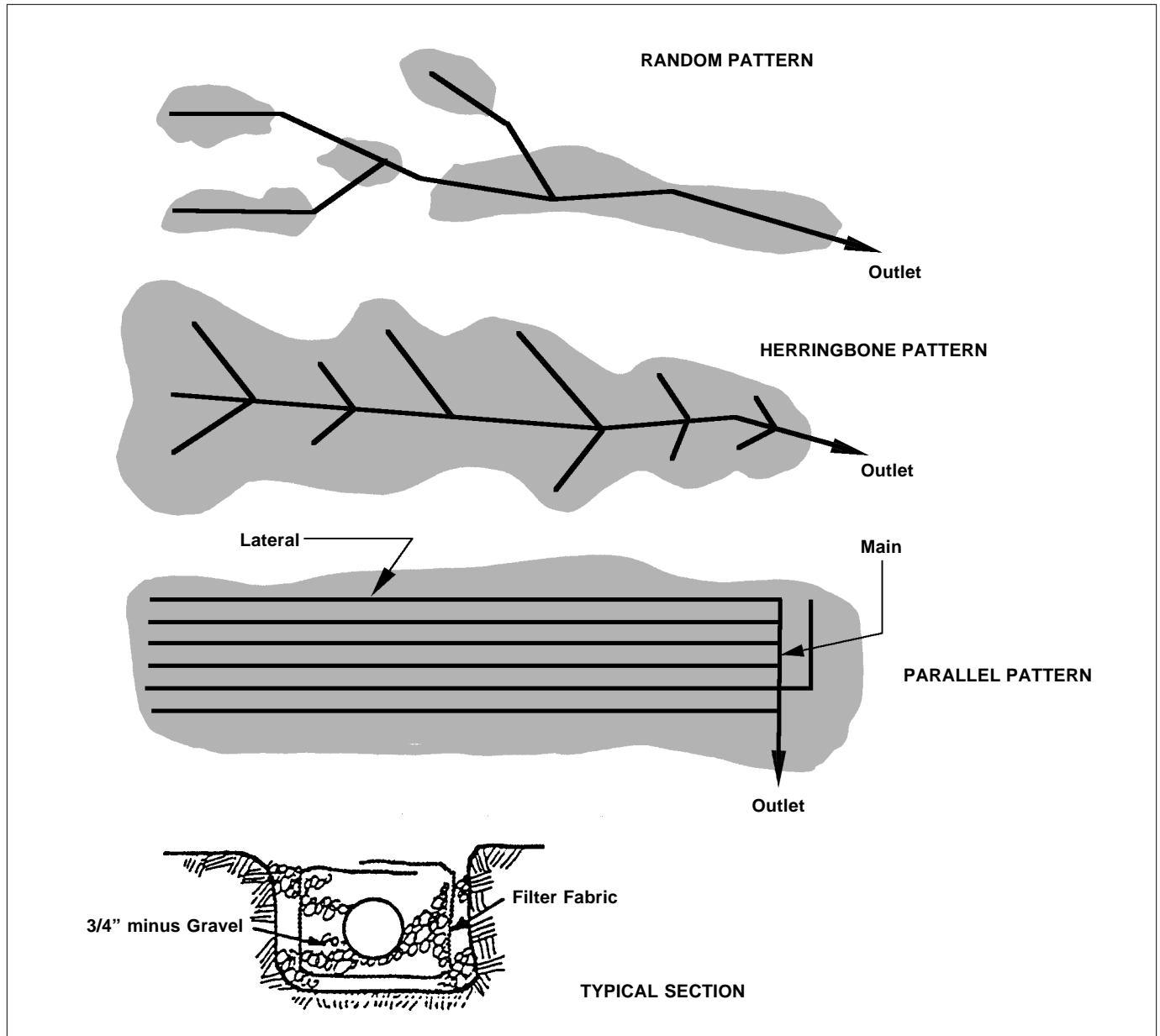
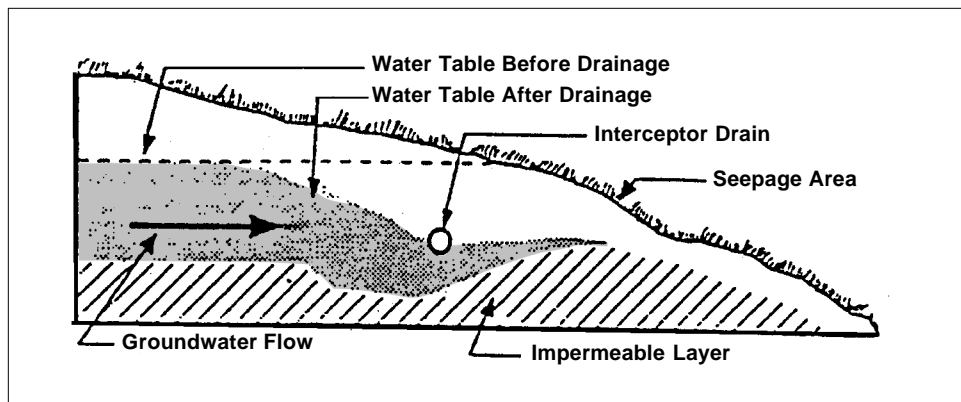




Figure 9. Effect of Subsurface Drain on Water Table



BMP E2.35: Surface Roughening

Code	Symbol
	

Definition

Provision of a rough soil surface with horizontal depressions created by operating a tiller or other suitable equipment on the contour or by leaving slopes in a roughened condition by not fine grading them.

Purpose

To aid in establishment of vegetative cover, reduce runoff velocity, increase infiltration, and provide for sediment trapping.

Conditions Where Practice Applies

All slopes steeper than 3:1, and greater than 5 vertical feet, require surface roughening; either stair-step grading, grooving, furrowing, or tracking if they are to be stabilized with vegetation.

Advantages

- Surface roughening provides some instant erosion protection on bare soil while vegetative cover is being established.
- It is an inexpensive and simple erosion control measure.

Disadvantages/Problems

While this is a cheap and simple method of erosion control, it is of limited effectiveness in anything more than a moderate storm.

Planning Considerations

Graded areas with smooth, hard surfaces give a false impression of “finished grading” and a job well done. It is difficult to establish vegetation on such surfaces due to reduced water infiltration and the potential for erosion. Rough slope surfaces with uneven soil and rocks left in place may appear unattractive or unfinished at first, but they encourage water infiltration, speed the establishment of vegetation, and decrease runoff velocity.

Rough, loose soil surfaces give lime, fertilizer, and seed some natural coverage. Niches in the surface provide microclimates that generally provide a cooler and more favorable moisture level than hard flat surfaces; this aids seed germination.

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

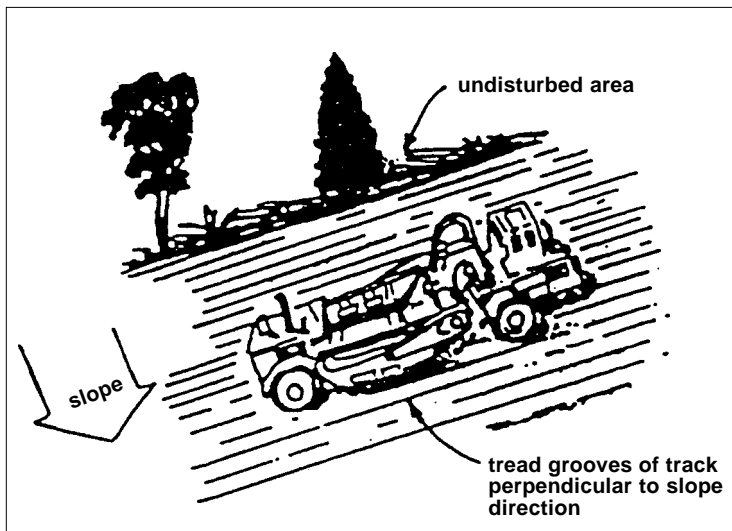
1. Disturbed areas that will not require mowing may be stair-step graded, grooved, or left rough after filling.
2. Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each “step” catches material that sloughs from above, and provides a level site where vegetation can become established. Stairs should be wide enough to work with standard earth moving equipment.
3. Areas that will be mowed (these areas should have slopes less steep than 3:1) may have small furrows left by disking, harrowing, raking, or seed-planting machinery operated on the contour.

4. It is important to avoid excessive compacting of the soil surface when scarifying. Tracking with bulldozer treads is preferable to not roughening at all, but is not as effective as other forms of roughening, as the soil surface is severely compacted and runoff is increased.

Design Criteria

Graded areas with slopes greater than 3:1 but less than 2:1 should be roughened before seeding (Figures 10-a and -b). This can be accomplished in a variety of ways, including “track walking,” or driving a crawler tractor up and down the slope, leaving a pattern of cleat imprints parallel to slope contours.

Graded areas steeper than 2:1 should be stair-stepped with benches as shown in Figure 11. The stair-stepping will help vegetation become established and also trap soil eroded from the slopes above.



Maintenance

- Areas that are graded in this manner should be seeded as quickly as possible.
- Regular inspections should be made of the area. If rills appear, they should be re-graded and re-seeded immediately.

Figure 10-a. Heavy Equipment Can Be Used to Mechanically Scarify Slopes

Figure 10-b. Unvegetated Slopes Should Be Temporarily Scarified to Minimize Runoff Velocities

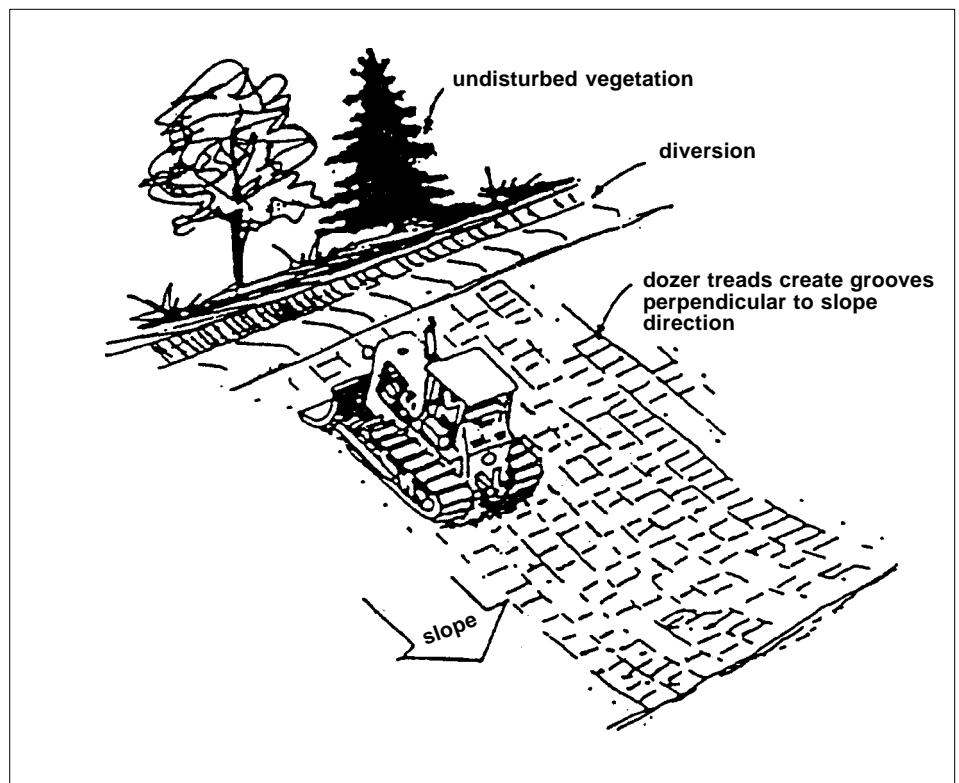
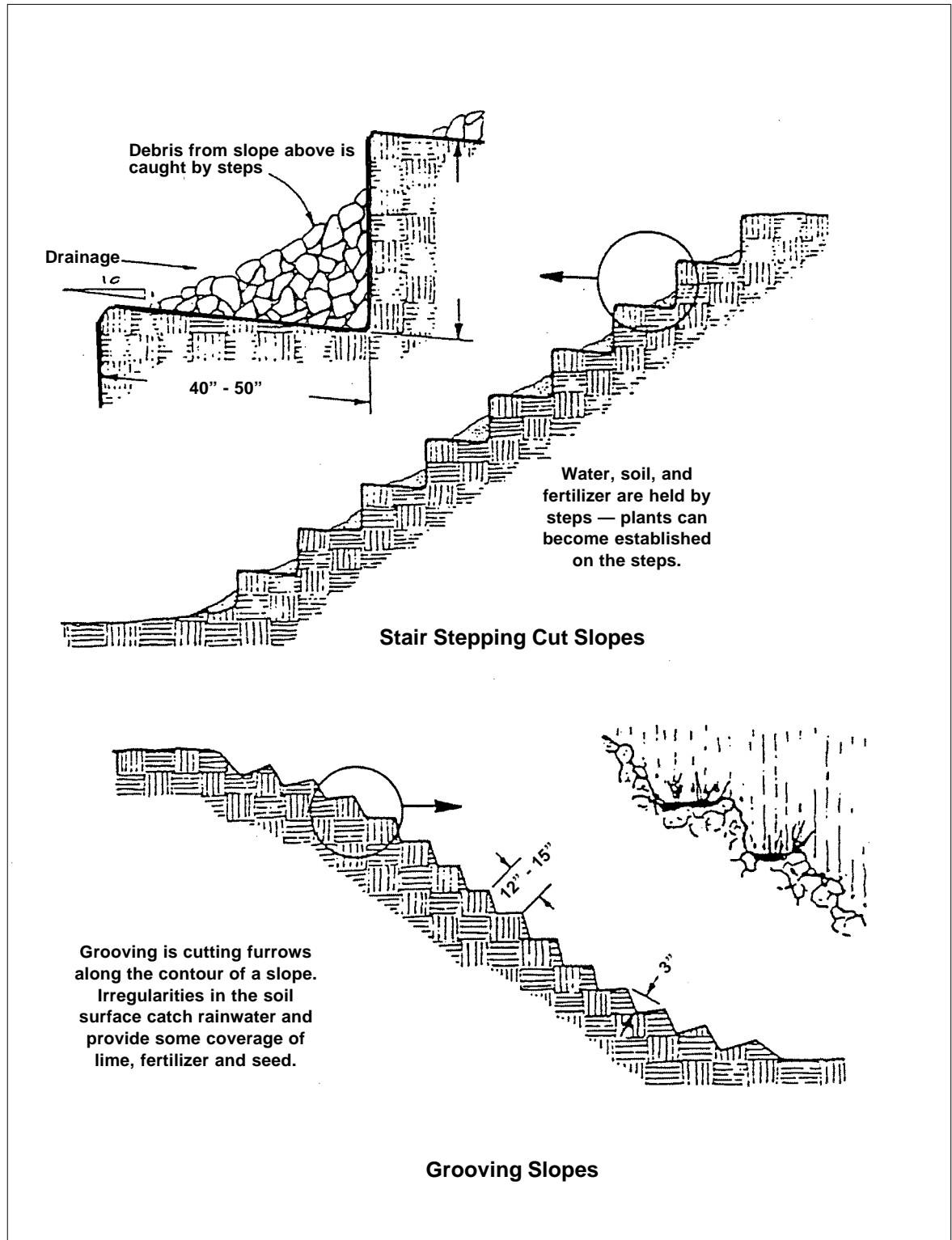




Figure 11. Stairstepping Cut Slopes and Grooving Slopes



BMP E2.40: Gradient Terraces

Code	Symbol
	

Definition

An earth embankment or a ridge-and-channel constructed with suitable spacing and with an acceptable grade.

Purpose

To reduce erosion damage by intercepting surface runoff and conducting it to a stable outlet at a non-erosive velocity. (This standard covers the planning and design of gradient terraces and does not apply to diversions.)

Conditions Where Practice Applies

Gradient terraces normally are limited to denuded land having a water erosion problem. They should not be constructed on deep sands or on soils that are too stony, steep, or shallow to permit practical and economical installation and maintenance. Gradient terraces may be used only where suitable outlets are or will be made available.

Advantages

Gradient terraces lower the velocity of runoff, increase the distance of overland flow, and reduce effective hydraulic gradient. They also hold moisture and minimize sediment.

Disadvantages/Problems

May significantly increase cut and fill costs and cause sloughing if excessive water infiltrates soils.

Design Criteria

- The maximum spacing of gradient terraces should be determined by the following method: $V.I. = xs + y$
 Where:
 - V.I. = vertical interval in feet
 - x = 0.8 for Washington
 - s = land slope in feet per 100 feet
 - y = a soil and cover variable with values from 1.0 to 4.0¹
- The minimum constructed cross-section should meet the design dimensions.
- The top of the constructed ridge should not be lower at any point than the design elevation plus the specified overfill for settlement. The opening at the outlet end of the terrace should have a cross section equal to that specified for the terrace channel.
- Channel Grade** - Channel grades may be either uniform or variable with a maximum grade of 0.6 feet per 100 feet length. For short distances, terrace grades may be increased to improve alignment. The channel velocity should not exceed that which is nonerosive for the soil type with the planned treatment.
- Outlet** - All gradient terraces should have adequate outlets. Such an outlet may be a grassed waterway, vegetated area, or tile outlet. In all cases the outlet must convey runoff from the terrace or terrace system to a point where the outflow will not cause damage. Vegetative cover should be used in the outlet channel.

¹ Values of "y" are influenced by soil erodibility and cover practices. The lower values are applicable to erosive soils where little to no residue is left on the surface. The higher value is applicable only to erosion-resistant soils where a large amount of residue (1-1/2 tons of straw/acre equivalent) is on the surface.

- The design elevation of the water surface of the terrace should not be lower than the design elevation of the water surface in the outlet at their junction, when both are operating at design flow.

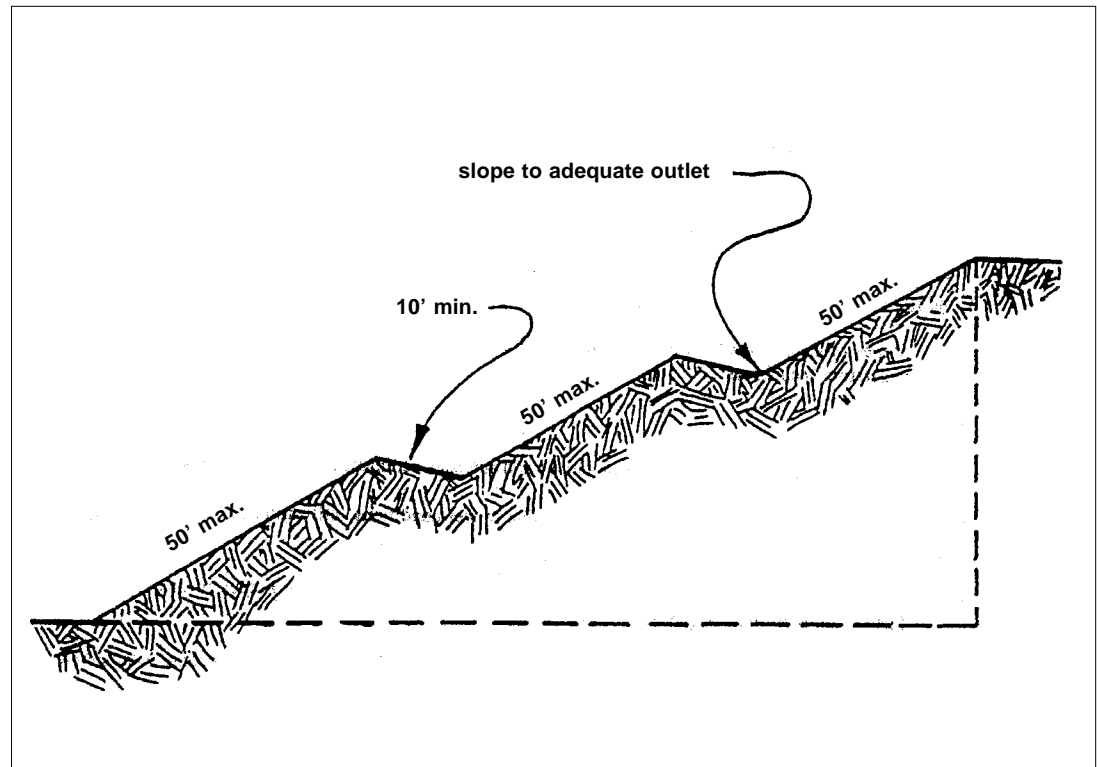
Specifications

- Vertical spacing determined by the above methods may be increased as much as 0.5 feet or 10%, whichever is greater, to provide better alignment or location, to avoid obstacles, to adjust for equipment size, or to reach a satisfactory outlet (Figure 12).
- The drainage area above the top should not exceed the area that would be drained by a terrace of equal length with normal spacing.
- **Capacity** - The terrace should have enough capacity to handle the peak runoff expected from a 2-year, 24-hour design storm without overtopping.
- **Cross-Section** - The terrace cross-section should be proportioned to fit the land slope. The ridge height should include a reasonable settlement factor. The ridge should have a minimum top width of 3 feet at the design height. The minimum cross-sectional area of the terrace channel should be 8 square feet for land slopes of 5% or less, 7 square feet for slopes from 5 to 8%, and 6 square feet for slopes steeper than 8. The terrace can be constructed wide enough to be maintained using a small cat.



Maintenance

Maintenance should be performed as needed. Terraces should be inspected regularly; at least once a year, and after large storm events.

Figure 12. Gradient Terraces



BMP E2.45: Bioengineered Protection of Very Steep Slopes

Code	Symbol
	

Definition

Steep slope protection using a combination of vegetative and mechanical measures.

Purpose

To stabilize steep banks.

Conditions Where Practice Applies

Slopes of steep grade, cut and fill banks, and unstable soil conditions that cannot be stabilized using ordinary vegetative techniques.

Advantages

- Vegetation reduces sheet erosion on slopes and impedes sediment at the toe of the slope.
- Where soils are unstable and liable to slip due to wet conditions, utilization of soil moisture by vegetation can reduce the problem.
- Shrubs and trees shelter slopes against the impact of rainstorms, and the humus formed by decaying leaves further helps to impede runoff.
- Mechanical measures help to stabilize soil long enough to allow vegetation to become established.

Disadvantages/Problems

- The planting of non-seeded material such as live willow brush is a specialized operation and cannot be highly mechanized or installed by unskilled labor.
- The methods described are effective but require a complete knowledge of soil, hydrology, and other physical data to design measures that will adequately solve the problem.

Design Criteria

The following bioengineering methods can be used after slopes have been protected by diversion of runoff (covered in BMP E2.55) or through the terracing of slopes (BMP E2.40).

- **Sod walls** or retaining banks are used to stabilize terraces. Sod is piled by tilting it slightly toward the slope and should be backfilled with soil and compacted as they are built up. Sod walls can be as steep as 1:8 but should not be higher than 5 feet (Figure 13a).
- **Timber frame stabilization** is effective on gradients up to 1:1 and involves the following steps in construction: 1) Lay soil retarding frames of 2 x 4 in. vertical members and 1 x 4 in. horizontal members on slopes. Frames on slopes over 15 feet in length need to be anchored to slope to prevent buckling. 2) Attach 14 gauge galvanized tire wires for anchoring wire mesh. 3) Fill frames with moist topsoil and compact the soil. 4) Spread straw 6 inches deep over slope. 5) Cover straw with 14 gauge 4-inch mesh galvanized reinforced wire. 6) Secure wire mesh at least 6 feet back of top slope. 7) Plant ground cover plants through straw into topsoil (Figure 13b).
- **Woven willow whips** (Figure 13c) may be used to form live barriers for immediate erosion control. Construction: 1) 3 foot poles are spaced at 5 foot distances and driven into the slope to a depth of 2 feet. 2) 2 foot willow sticks are inserted between poles at

one foot distances. 3) Live willow branches of 5 foot length are sunk to a depth of 1 inch and interwoven with poles and stocks. 4) Spaces between the woven ‘fences’ are filled with topsoil. Fences are generally arranged parallel to the slope or in a grid pattern diagonal to the direction of the slope.

- **Berm Planting.** 1) Excavate ditches from 3 to 5 feet apart along the slope and shape a berm on the downslope side. Construct ditches with 5% longitudinal slope. 2) Plant rooted cuttings on 3 foot centers and mulch. Suitable trees are willow, alder, birch, pine, and selected shrubs. In extremely dry situations, rooted cuttings can be planted in biodegradable plastic bags that are watered at the time of planting (Figure 13d).
- **Brush Layers.** 1) Prepare 3 foot “niches” as shown. 2) Lay unrooted 5 foot live branches of willow or poplar at close spacing. 3) Starting at foot of slope, backfill lower ditch with excavated material from ditch above it. Operation should be carried out during dormant season (Figure 13e).

Maintenance

- Regardless of the stabilization method used, inspections should be made on a regular basis to make sure the system is functioning correctly.
- Note: There are a number of manufacturers who provide prefabricated bioengineered devices for the protection of steep slopes.

Figure 13. Bioengineered Protection of Very Steep Slopes

Figure 13a. Sod Retaining Bank

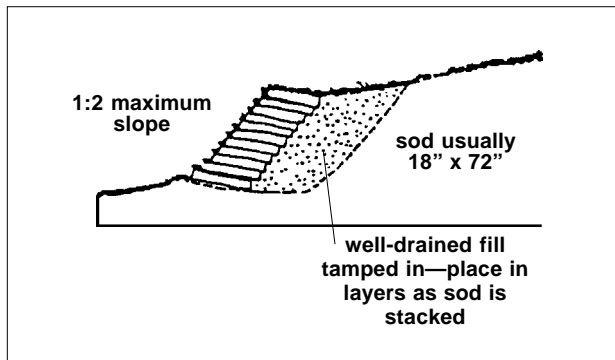


Figure 13b. Timber Frame Stabilization

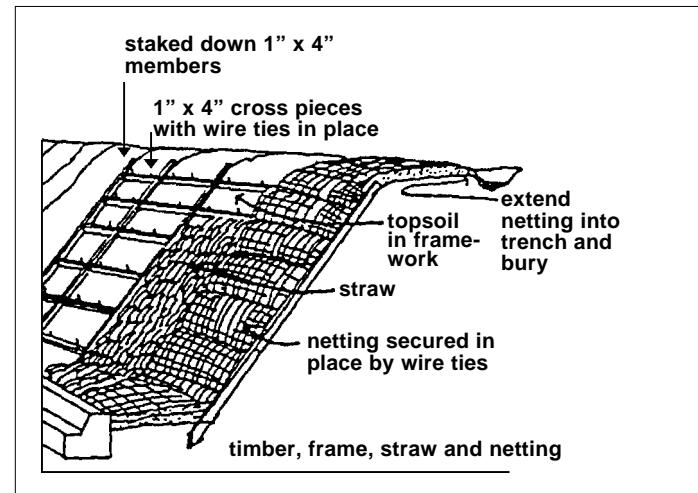


Figure 13c. Woven Willow Whips

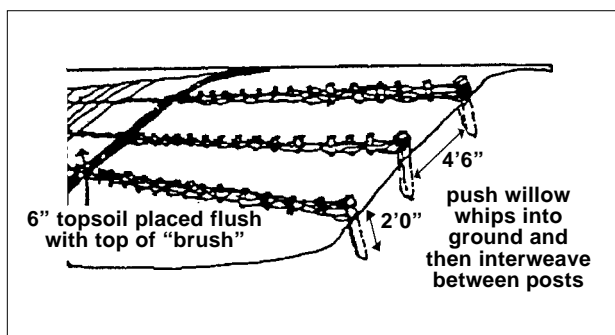


Figure 13d. Berm Planting Section

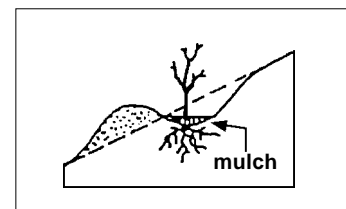
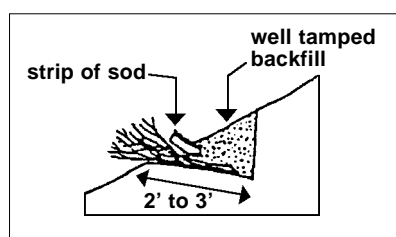



Figure 13e. Brush Layers Section



BMP E2.50: Level Spreader

Code	Symbol
LS	

Definition

A temporary outlet for dikes and diversions consisting of an excavated depression constructed at zero grade across a slope.

Purpose

To convert concentrated runoff to sheet flow and release it onto areas stabilized by existing vegetation or an engineered filter strip.

Condition Where Practice Applies

To be constructed on undisturbed areas that are stabilized by existing vegetation and where concentrated flows are anticipated to occur at 0% grade.

Advantages

Level spreaders disperse the energy of concentrated flows, reducing erosion potential and encouraging sedimentation.

Disadvantages/Problems

If the level spreader has any low points, flow tends to concentrate there. This concentrated flow can create channels and cause erosion. If the spreader serves as an entrance to a water quality treatment system, short-circuiting of the forebay may happen and the system will be less effective in removing sediment and particulate pollutants.

Planning Considerations

Interceptor dikes and swales (BMP E2.55) call for a stable outlet for concentrated stormwater flows. The level spreader can be used for this purpose provided the runoff is relatively free of sediment. If properly constructed, the level spreader will significantly reduce the velocity of concentrated stormwater and spread it uniformly over a stable undisturbed area.

Particular care must be taken during construction to ensure that the lower lip of the structure is level. If there are any depressions in the lip, flow will tend to concentrate at these points and erosion will occur, resulting in failure of the outlet. This problem may be avoided by using a grade board or a gravel lip over which the runoff must flow when exiting the spreader. Regular maintenance is essential for this practice.

Design Criteria

- The grade of the channel for the last 20 feet of the dike or interceptor entering the level spreader shall be less than or equal to 1%. The grade of the level spreader shall be 0% to ensure uniform spreading of storm runoff (Figure 14).

Table 8. Spreader length based on 25-yr, 24-hour storm

Q_{25} , in CFS	Minimum Length (in feet)
0 - 0.1	15
0.1 - 0.2	20
0.2 - 0.3	30
0.3 - 0.4	40

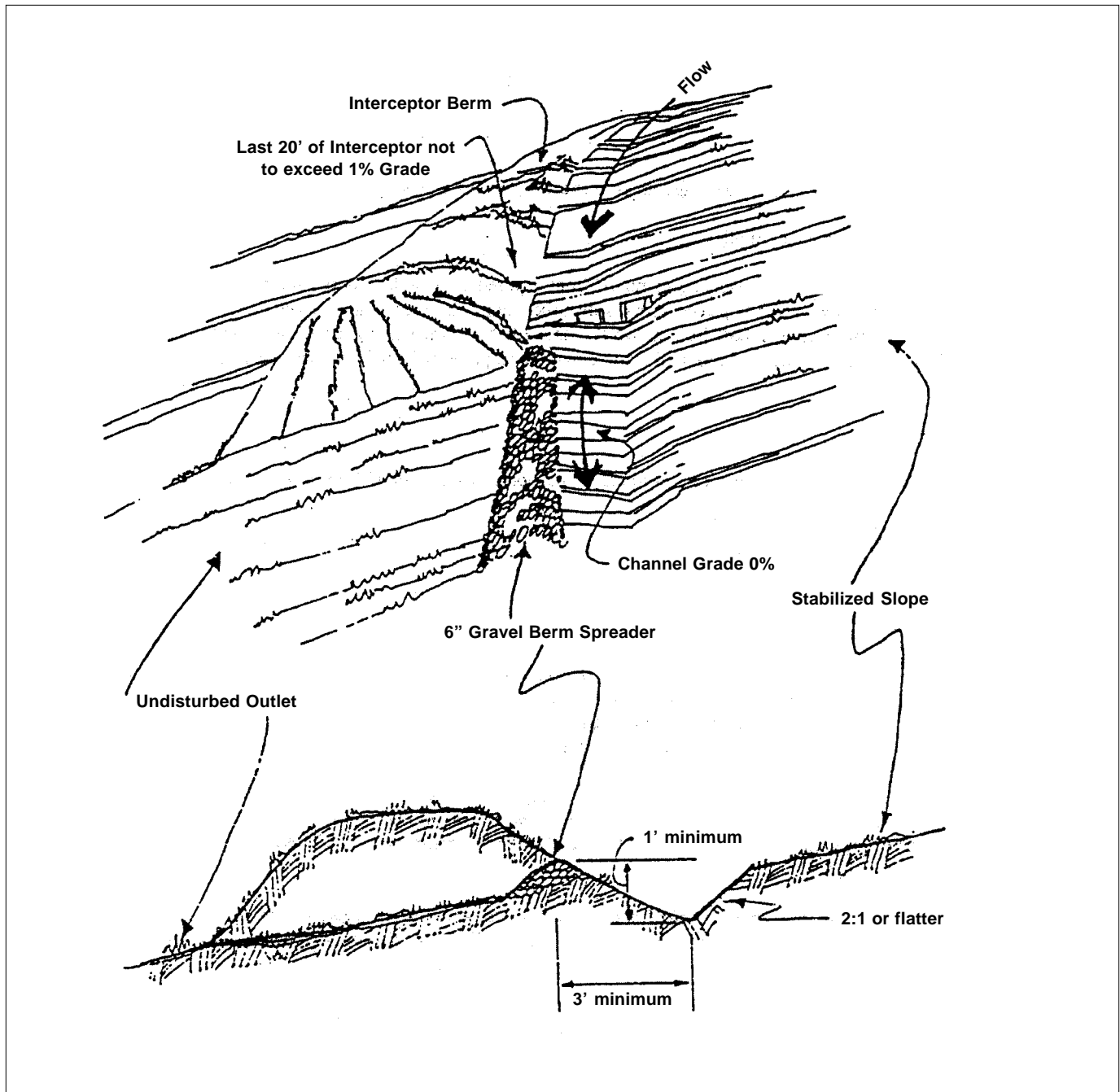
- A 6-inch high gravel berm placed across the level lip shall consist of washed crushed rock, 2 to 4 inch or 3/4 inch to 1.5 inch size.
- The spreader length will be determined by estimating the flow expected from the 25-year, 24-hour design (Q_{25}), and selecting the appropriate length from Table 8.

- The width of the spreader should be at least 6 feet.
- The depth of the spreader as measured from the lip should be at least 6 inches and it should be uniform across the entire length.
- The slope of the undisturbed outlet should not exceed 6%.


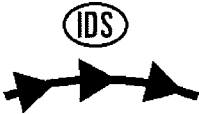
Maintenance

The spreader should be inspected after every runoff event to ensure that it is functioning correctly. The contractor should avoid the placement of any material on or prevent construction traffic across the structure. If the spreader is damaged by construction traffic, it shall be immediately repaired.

Figure 14: Level Spreader



BMP E2.55: Interceptor Dike and Swale

Code	Symbol
	

Definition

A ridge of compacted soil or a swale with vegetative lining located at the top or base of a sloping disturbed area.

Purpose

To intercept storm runoff from drainage areas above unprotected slopes and direct it to a stabilized outlet.

Conditions Where Practice Applies

Where the volume and velocity of runoff from exposed or disturbed slopes must be reduced. When an interceptor dike/swale is placed above a disturbed slope, it reduces the volume of water reaching the disturbed area by intercepting runoff from above (Figures 15-a and -b). When it is placed horizontally across a disturbed slope, it reduces the velocity of runoff flowing down the slope by reducing the distance that the runoff can flow directly downhill.

Advantages

This BMP provides a practical, inexpensive method to divert runoff from erosive situations.

Disadvantages/Problems

None

Planning Considerations

A temporary diversion dike or swale is intended to divert overland sheet flow to a stabilized outlet or a sediment trapping facility during establishment of permanent stabilization on a sloping disturbed area. When used at the top of a slope, the structure protects exposed slopes by keeping upland runoff away. When used at the base of a slope, the structure protects adjacent and downstream areas by diverting sediment-laden runoff to a sediment trapping facility.

If the dike or swale is going to remain in place for longer than 15 days, it shall be stabilized with temporary or permanent vegetation. The slope behind the dike or swale is also an important consideration. The dike or swale must have a positive grade to assure drainage, but if the slope is too great, precautions must be taken to prevent erosion due to high velocity of flow.

This practice is considered an economical one because it uses material available on the site and can usually be constructed with equipment needed for site grading. Stabilizing the dike or swale with vegetation can extend the useful life of the practice.

Design Criteria

- **Interceptor dikes shall meet the following criteria:**

Table 9. Design Criteria for Interceptor Dikes

Feature	Requirement
Top Width	2 ft min.
Height	18 " min. Measured from upslope toe and at a compaction of 90% ASTM D698 standard proctor.
Side Slopes	2:1 or flatter.
Grade	Topography dependent, except that dike shall be limited to grades between 0.5 and 1.0 %.
Horizontal Spacing of Interceptor Dikes	<ul style="list-style-type: none"> • Slopes <5% = 300 feet • Slopes 5-10% = 200 feet • Slopes 10-40% = 100 feet
Stabilization	Slopes = <5% Seed and mulched construction (see BMP E1.10). Slopes = 5-40% Dependent on runoff velocities and dike materials. Stabilization should be done immediately using either sod or riprap to avoid erosion.
Outlet	The upslope side of the dike shall provide positive drainage to the dike outlet. No erosion shall occur at the outlet. Provide energy dissipation measures as necessary. Sediment-laden runoff must be released through a sediment trapping facility.
Other	Minimize construction traffic over temporary dikes.

- **Interceptor swales shall meet the following criteria:**

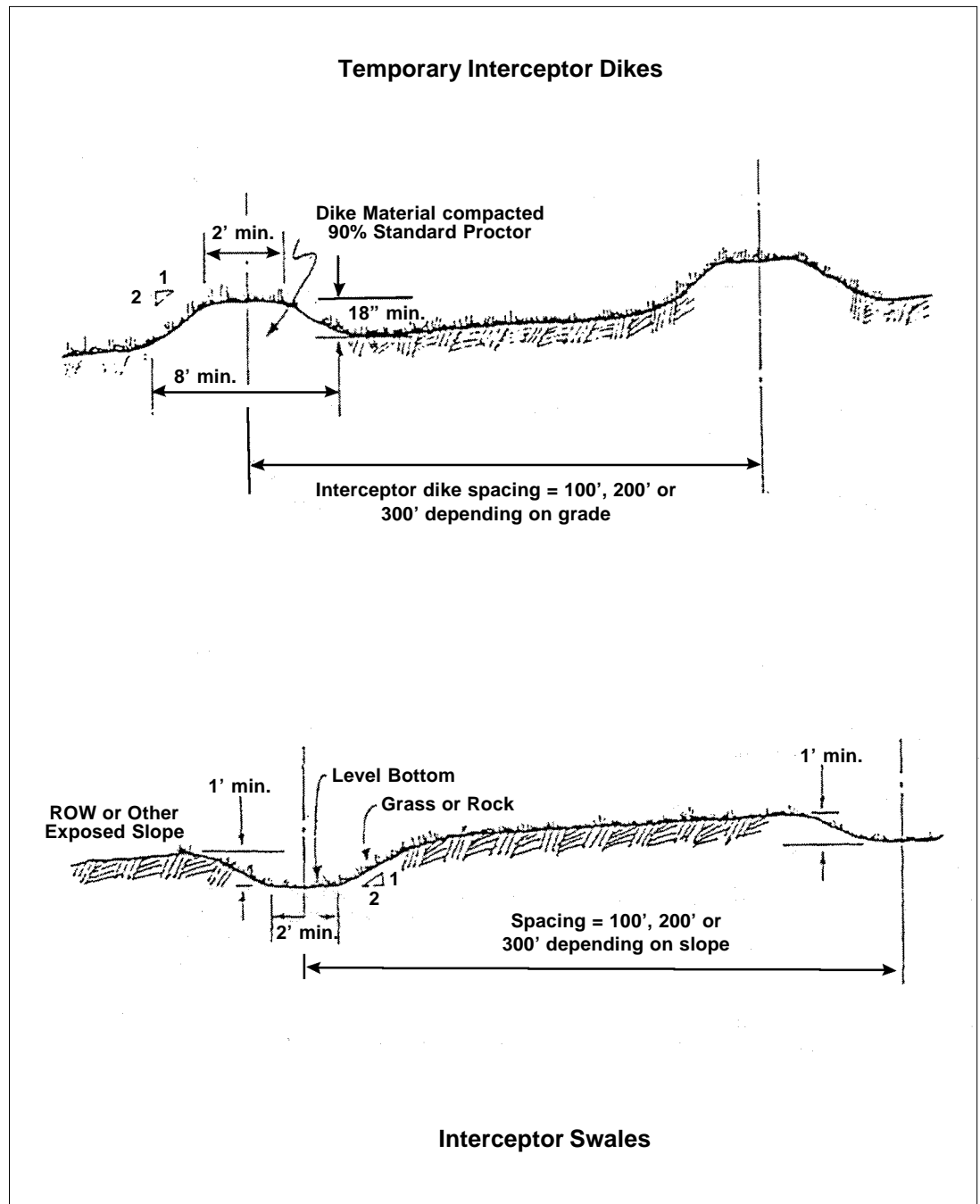
Table 10. Design Criteria for Interceptor Swales

Feature	Requirement
Bottom Width	2 ft min. Bottom shall be level.
Depth	1 ft min.
Side Slopes	2:1 or flatter.
Grade	5% max. w/ positive drainage to suitable outlet such as a sediment trap.
Stabilization	Seed as per BMP E1.10 temporary seeding or E2.75. Riprap 12" thick pressed into bank and extending at least 8" vertical from the bottom.
Stabilization	Slope of disturbed area: <5% = 300 feet 5-10% = 200 feet 10-40% = 100 feet
Outlet	Level spreader or riprap to stabilized outlet/sedimentation pond.



Maintenance

- The measure should be inspected after every major storm and repairs made as necessary. Damage caused by construction traffic or other activity must be repaired before the end of each working day.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

Figure 15-a and -b. Temporary Interceptor Dike (a) and Interceptor Swale (b)



BMP E2.60: Check Dams

Code	Symbol
	

Definition

Small dams constructed across a swale or drainage ditch.

Purpose

To reduce the velocity of concentrated flows, reducing erosion of the swale or ditch, and to slow water velocity to allow retention of sediments.

Conditions Where Practice Applies

- Where temporary channels or permanent channels are not yet vegetated, channel lining is infeasible and, therefore, velocity checks are required.
- In small open channels which drain 10 acres or less. No check dams may be placed in streams (unless approved by the State Departments of Fisheries or Wildlife as appropriate). Other permits may also be necessary.
- Check dams in association with sumps work more effectively at slowing flow and retaining sediment.

Advantages

- Check dams not only prevent gully erosion from occurring before vegetation is established, but also cause a high proportion of the sediment load in runoff to settle out.
- In some cases, if carefully located and designed, these check dams can remain as permanent installations with very minor regrading, etc. They may be left as either spillways, in which case accumulated sediment would be graded and seeded, or as check dams to precipitate further sediment coming off that site.

Disadvantages/Problems

- Because of their temporary nature, many of these measures are unsightly, and they should be removed or converted to permanent check dams before dwelling units are rented or sold.
- Removal may be a significant cost depending on the type of check dam installed.
- Temporary check dams are only suitable for a limited drainage area.
- Clogging by leaves in the fall may be a problem.

Planning Considerations

Check dams can be constructed of either stone, logs, or pea gravel filled sandbags. Log check dams may be more economical from the standpoint of material costs, since logs can often be salvaged from clearing operations. However, log check dams require more time and hand labor to install. Stone for check dams, on the other hand, must generally be purchased. However, this cost is offset somewhat by the ease of installation.

If stone check dams are used in grass-lined channels that will be mowed, care should be taken to remove all the stone from the channel when the dam is removed. This should include any stone that has washed downstream.

Since log check dams are embedded in the soil, their removal will result in more disturbance of the soil than will removal of stone check dams. Consequently, extra care should be taken to stabilize the area when log dams are used in permanent ditches or swales.

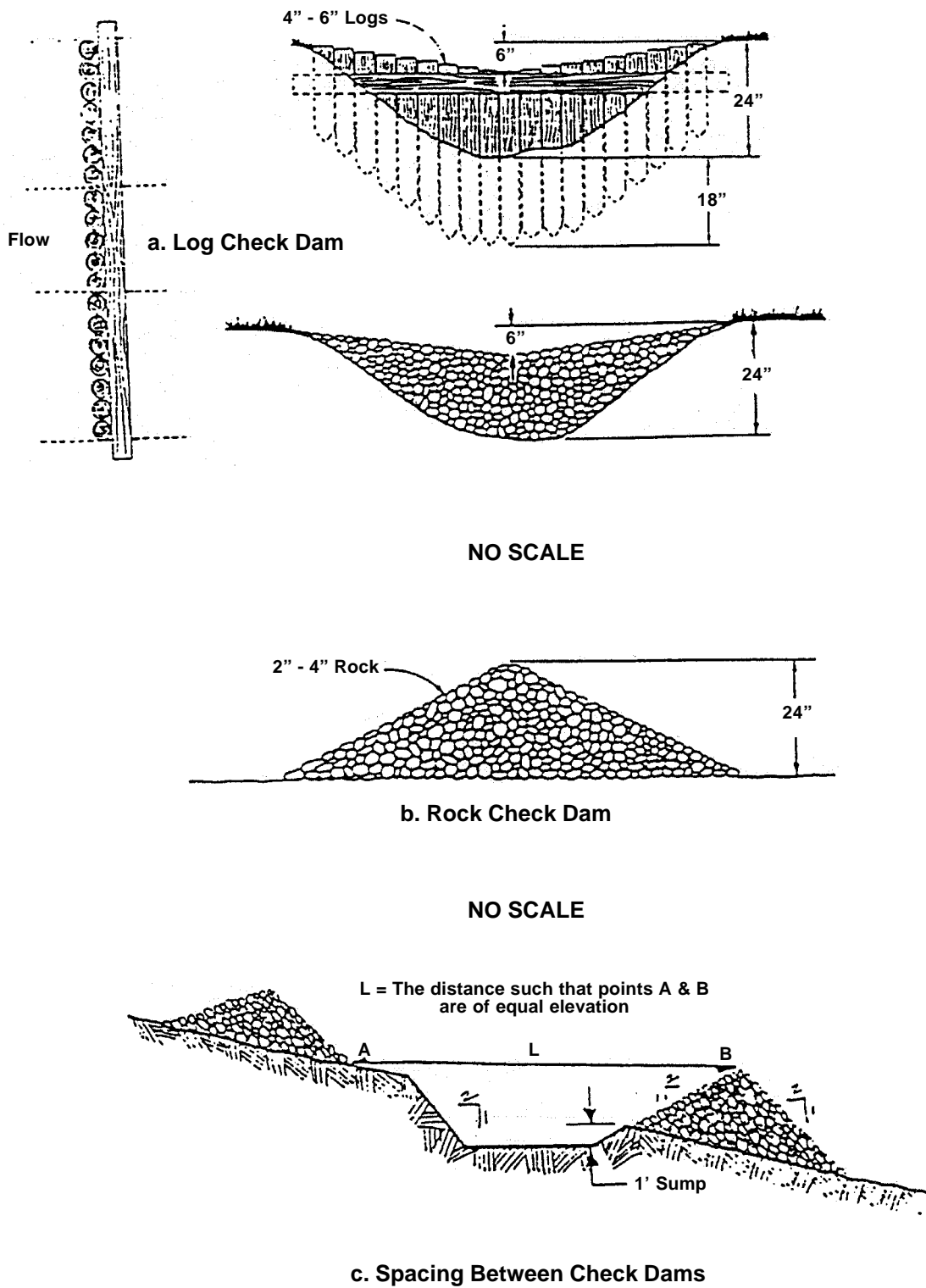
Design Criteria

- Check dams can be constructed of rock, pea-gravel filled bags or logs (Figures 16-a and -b). Provide a deep sump immediately upstream (see Figure 16c).
- The maximum spacing between the dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam (Figure 16c).
- Rock check dams shall be constructed of appropriately sized rock. The rock must be placed by hand or mechanical placement (no dumping of rock to form dam) to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges. The rock used must be large enough to stay in place given the expected design flow through the channel.
- Log check dams shall be constructed of 4 to 6-inch diameter logs. The logs shall be embedded into the soil at least 18 inches (Figure 16a).
- In the case of grass-lined ditches and swales, check dams shall be removed when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4%. The area beneath the check dams shall be seeded and mulched immediately after dam removal.


Maintenance

- Check dams shall be monitored for performance and sediment accumulation during and after each runoff producing rainfall. Sediment shall be removed when it reaches one half the sump depth.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

Figure 16-a, -b and -c. Check Dams



BMP E.2.70 Outlet Protection

Code	Symbol
OP	

Definition

Structurally lined aprons or other acceptable energy dissipating devices placed at the outlets or pipes or paved channel sections.

Purpose

To prevent scour at stormwater outlets, and to minimize the potential for downstream erosion by reducing the velocity of concentrated stormwater flows.

Condition Where Practice Applies

Applicable to the outlets of all pipes, interceptor swale outlets, and channel sections where the velocity of flow at the design capacity of the outlet will exceed the permissible velocity of the receiving channel or area.

Advantages

- Plunge pools that can develop without outlet protection may severely weaken the embankment and thus threaten its stability.
- Protection can prevent scouring at a culvert mouth and thus prevent gully erosion that may gradually extend upstream.

Disadvantages/Problems

- Some types of structures may be unsightly.
- Sediment removal may be difficult.

Planning Considerations

An outfall is defined as a concentrated discharge point that directs collected surface water flows into an open drainage feature, natural or manmade. These drainage features include ditches, channels, swales, closed depressions, wetlands, streams, rivers, ponds, lakes, or other open bodies of water. In nearly every case, the outfall will consist of a pipe discharging flows from a storm pipe system, a culvert, or a detention facility.


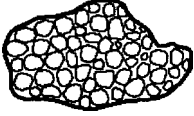
Design Criteria

See the Director's Rule on Detention Requirements.

Maintenance

All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual. Rock may need to be added if sediment builds up in the pore spaces of the outlet pad.

BMP E2.75: Riprap

Code	Symbol
	

Definition

A permanent, erosion-resistant ground cover of large, loose, angular stone.

Purpose

To slow the velocity of concentrated runoff or to stabilize slopes with seepage problems and/or non-cohesive soils by placement of large, loose, angular stone.

Conditions Where Practice Applies

Soil-water interfaces, where the soil conditions, water turbulence, water velocity, and expected vegetative cover, are such that the soil may erode under the design flow conditions.

Advantages

- Riprap offers an easy-to-use method for decreasing water velocity and protecting slopes from erosion. It is simple to install and maintain.
- Riprap provides some water quality benefits by increasing roughness and decreasing the velocity of the flow, inducing settling.

Disadvantages/Problems

- Riprap is more expensive than vegetated slopes.
- Riprap does not provide the habitat enhancement that other vegetative BMPs do.

Planning Considerations: Graded vs. Uniform Riprap

Riprap is classified as either graded or uniform. A sample of graded riprap would contain a mixture of stones that vary in size from small to large. A sample of uniform riprap would contain stones which are all fairly close in size.

For most applications, graded riprap is preferred to uniform riprap. Graded riprap forms a flexible self-healing cover, while uniform riprap is more rigid and cannot withstand movement of the stones. Graded riprap is cheaper to install, requiring only that the stones be dumped so that they remain in a well-graded mass. Hand or mechanical placement of individual stones is limited to that necessary to achieve the proper thickness and line. Uniform riprap requires placement in a more or less uniform pattern, requiring more hand or mechanical labor.

Riprap sizes can be designated by either the diameter or the weight of the stones. It is often misleading to think of riprap in terms of diameter, since the stones should be rectangular instead of spherical. However, it is simpler to specify the diameter of an equivalent size of spherical stone. Table 4 below lists some typical stones by weight, spherical diameter and the corresponding rectangular dimensions. These stone sizes are based upon an assumed specific weight of 165 lbs./ft³

Design Criteria

Table 11. Typical Weight of Riprap Stones

Weight (lbs)	Mean Spherical diameter (ft)	Rectangular Shape Length (ft)	Width, Height (ft)
50	0.8	0.25	0.5
100	1.1	1.75	0.6
150	1.3	2.0	0.67
300	1.6	2.6	0.9
500	1.9	3.0	1.0
1,000	2.2	3.7	1.25
1,500	2.6	4.7	1.5
2,000	2.75	5.4	1.8
4,000	3.6	6.0	2.0
6,000	4.0	6.9	2.3
8,000	4.5	7.6	2.5
20,000	6.1	10.0	3.3

Since graded riprap consists of a variety of stone sizes, a method is needed to specify the size range of the mixture of stone. Specifying a diameter of stone in mixture for which some percentage, by weight, will be smaller does this. For example, d_{85} refers to a mixture of stones in which 85% of the stone by weight would be smaller than the diameter specified. Most designs are based on d_{50} . In other words, the design is based on the median size of stone in the mixture.



Sequence of Construction

Since riprap is used where erosion potential is high, construction must be sequenced so that the riprap is put in place with the minimum possible delay. Disturbance of areas where riprap is to be placed should be undertaken only when final preparation and placement of the riprap can follow immediately behind the initial disturbance. Where riprap is used for outlet protection, the riprap should be placed before or in conjunction with the construction of the pipe or channel so that it is in place when the pipe or channel begins to operate.

Maintenance

- Riprap coverings should be inspected on a regular basis and after every large storm event.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.

BMP E2.80: Vegetative Streambank Stabilization

Code	Symbol
	

Definition

The use of vegetation as building material to stabilize streambanks and restore landscapes.

Purpose

To protect streambanks against erosion, and benefit fish and wildlife through vegetative means.

Condition Where Practice Applies

Applicable to water areas and all land uses. To be used to stabilize banks in swales, creeks, streams, and rivers as well as man-made ditches, canals and impoundments, including ponds and storage basins.

Advantages

- Streambank vegetation can break wave action and the velocity of flood flows.
- Roots and rhizomes stabilize streambanks.
- The reduction of velocity can lead to the deposit of water-borne soil particles.
- Certain reeds and bulrushes have the capability of improving water quality by absorbing certain pollutants such as heavy metals, detergents, phenols, and indols (1).
- Plants regenerate themselves and adapt to changing natural situations, thus offering a distinct economic advantage over mechanical stabilization.
- Wildlife and fisheries habitat is improved. Larger plants such as willows can help to shade out nuisance species such as reed canary grass.

Disadvantages/Problems

- Native plants may not be carried by regular nurseries and may need to be collected by hand, or obtained from specialty nurseries. Nurseries that carry these plants may require a long lead time for large orders.
- Flow retarding aspects of vegetated waterways need to be taken into account during the design phase.

Planning Considerations

A primary cause of stream channel erosion is the increased frequency of bank-full flows, which often results from upstream development. Most natural stream channels are formed with a bank-full capacity to pass the runoff from a storm with a 1.5 to 2-year recurrence interval. However, in a typical urbanizing watershed, stream channels may become subject to a 3 to 5-fold increase in the frequency of bank-full flows if stormwater runoff is not properly managed. As a result, stream channels that were once parabolic in shape and covered with vegetation may be transformed into wide rectangular channels with barren banks.

In recent years, a number of structural measures have evolved to strengthen and protect the banks of rivers and streams. These methods, when employed correctly, immediately ensure satisfactory protection of the banks. However, many such structures are expensive to build and to maintain. Without constant upkeep, natural agents can progressively deteriorate these structures. The materials used often prevent the reestablishment of native plants and animals, especially when the design is executed according to standard cross-sections, which ignore natural variations of the stream system. Very often these structural measures destroy the appearance of the site. Additionally, structural stabilization and

channelization can alter the hydrodynamics of a stream and only serve to transfer erosion potential and associated problems downstream.

In contrast, the utilization of living plants instead of or in conjunction with structures has many advantages. The degree of protection, which may be low to start with, increases as the plants grow and spread. The repair and maintenance of structures is unnecessary where self-maintaining streambank plants are established. The protection provided by natural vegetation is more reliable and effective when the cover consists of natural plant communities adapted to their site.

Design Criteria

- Design must be prepared based on criteria and input/review by a qualified fisheries biologist.
- Streambanks can be divided into: 1) aquatic plant zones at the mean low-water level (MWL); 2) reed bank zones covered at bankfull stage (BF); 3) lower riparian zones or open floodway zones naturally covered with willows and shrubby plants (OF); 4) upper riparian areas or flood fringe areas that would naturally be covered with canopy-forming trees (FF) (see Figure 17a).
- **Aquatic plants** are often considered weeds and a nuisance though they do slow down streamflow and protect the streambed. Primary emphasis of streambank stabilization lies in the bankfull zone.
- The **reed bank zone** forms a permeable obstacle, slowing down current waves by friction. Suitable plants can be found by consulting the guidelines found in Chapter III-5 of the State Stormwater Manual. Their shoots, with a root clump, can be planted in pits at 1/2 to 1 a foot depth below water, or in a reed roll as in Figure 18b. A trench 1-1/2 feet wide and deep is dug behind a row of stakes; wire netting is then stretched from both sides between upright planks; coarse gravel is dumped on this and covered with reed clumps until the two edges of the netting can just be held together with wire. The upper edge of the roll should not be more than two inches above water level. Finally, the planks are taken out and gaps in the ditch are backfilled.
- The **lower riparian zone** in the Puget Sound region has a natural growth of willow, alder, cottonwood, small maples, and various berries. These vegetative types can be reintroduced on denuded floodplains to stabilize the soil with their roots. In periods of high water, their upper branches reduce the speed of the current and thereby the erosive force of water. The most commonly used vegetative stabilizer for this zone is willow because of its capability to develop secondary roots on cut trunks and to throw up suckers. Willows are planted either as individual cuttings bound together in various forms or wired together in “fascines.”
- Fascines (Figure 198a) have a diameter of 3 to 12 inches and contain brushwood and sticks and coarse gravel or rubble in the center tightly wound around. Packed fascine-work (Figure 18b) can be employed on cut banks. It consists of 1-foot layers of branches covered with young, freshly cut shoots secured by stakes. The spaces between the shoots are filled with dirt and another layer is added on top. Another technique is the use of willow mattresses (Figure 18c) made from 4 to 6 foot willow switches set into 6-inch trenches held down by stakes that are braided or wired together. The entire mattress is lightly covered with dirt. A variation of this method is the brush-mesh technique, which is designed to stabilize breached cut banks and to encourage the deposition of sediment (Figure 18-d). It involves the following steps:
 1. Placement of poles at 10-foot distance.

2. Placement of large branches and brush facing the stream.
 3. Setting cuttings of live willow branches between the brush vertically, and
 4. Securing vertical willows with cuttings set diagonally facing the streamflow.
- Slip banks of the lower riparian zone and tidal banks can be stabilized with grass (3). First the bank needs to be graded to a maximum slope of 3:1. Topsoil should be conserved for reuse; lime (2 tons/acre) and fertilizer (1,000 lbs/acre of 10:10:10) should be applied. Coarse grass and beach grass should be planted at the water's edge to trap drift sand; and Bermuda grass, suitable for periodic inundation, should occupy the face of the slope, followed by tall fescue on higher ground.
 - Unless irrigation is planned, fall planting will help to better establish plants before cold weather and high water arrives.

Maintenance

- Streambanks are always vulnerable to new damage. Repairs are needed periodically. Banks should be checked after every high-water event is over. Gaps in the vegetative cover should be fixed at once with new plants, and mulched if necessary. Fresh cuttings from other plants on the bank can be used, or they can be taken from mother-stock plantings if they are available.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.

References

¹Seibert, P., Importance of Natural Vegetation for the Protection of the Banks of Streams, Rivers and Canals: Freshwater, The Council of Europe. Manhattan Publishing Co., New York, 1968.

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³Schiectl, Hugo, Bioengineering for Land Reclamation and Conservation, University of Alberta Press, 1980.

⁴Juelson, Thomas C., Suggestions for Stream Bank Revegetation in Western Washington, Applied Wildlife Biology, Habitat Management Division, Washington Department of Game, February, 1980.

Figures 17-a and -b Vegetative Streambank Stabilization

Figure 17-a. Streambank Vegetative Zones

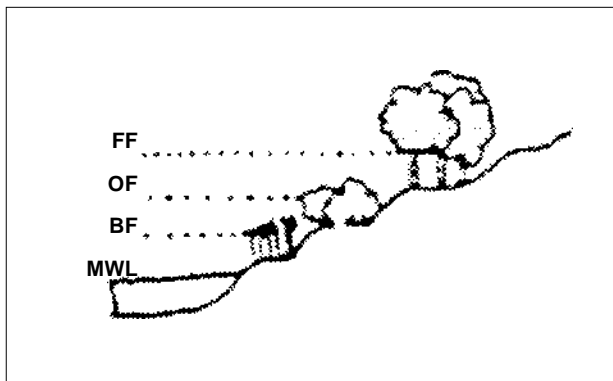
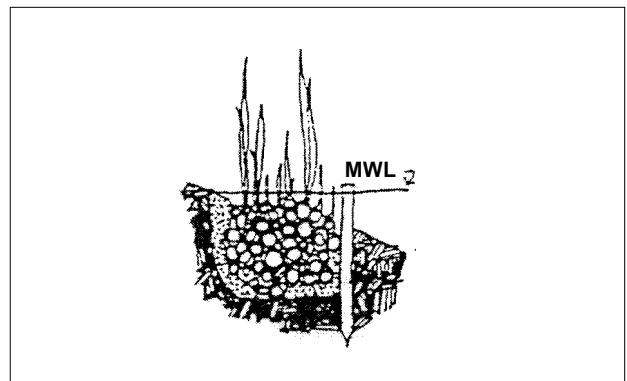


Figure 17-b. Reed Roll



Figures 18-a, -b, -c and -d. Vegetative Streambank Stabilization

Figure 18-a. Fascines

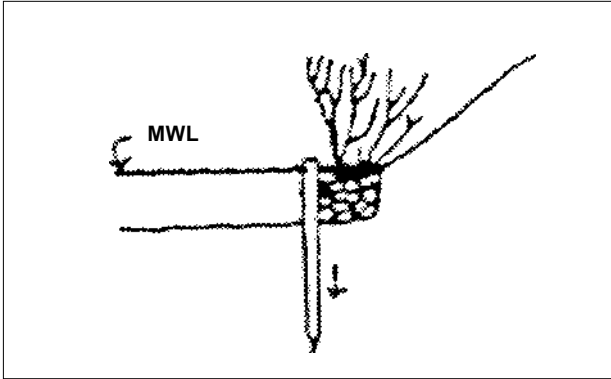


Figure 18-b. Packed Fascine-Work

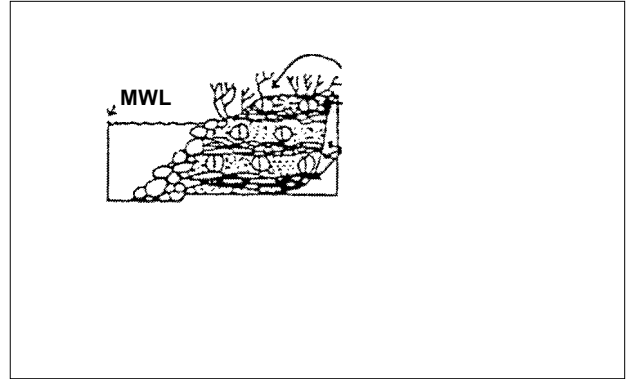


Figure 18-c. Willow Mattress

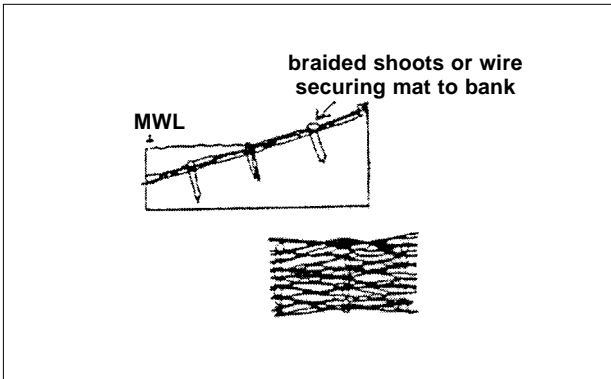
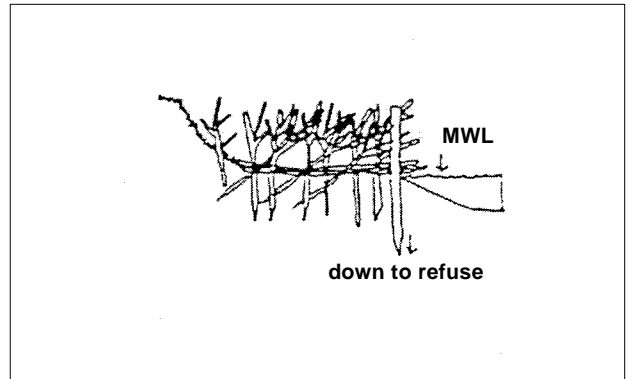




Figure 18-d. Brush-Mesh Protection



BMP E2.85: Bioengineering Methods of Streambank Stabilization

Code	Symbol
	

Definition

Methods of stabilizing streambanks through a combination of vegetative and mechanical means.

Purpose

To provide protection of critical sections of streambank where ordinary vegetative means of protection are not feasible or offer insufficient protection.

Conditions Where Practice Applies

To be used in streams with swift flow where the flow/soil conditions exceed the stabilizing effect of purely vegetative channel protection.

Advantages

- Mechanical materials provide for interim and immediate stabilization until vegetation takes over.
- Once established, vegetation can outlast mechanical structures and regenerates itself with little maintenance.
- Aesthetic benefits and wildlife habitat.

Disadvantages/Problems

- Slightly higher initial cost and need for professional advice. (It is recommended that the services of a qualified bioengineer be sought for this work).
- The methods described are effective but require a complete knowledge of soils, hydrology, and other physical data to design measures that will adequately solve the problem and stand up to the test of time.

Design Criteria

Streams in urban settings may carry an increase in runoff of such great magnitude that they cannot be maintained in a natural state. In these cases bioengineering methods can provide for stabilization without complete visual degradation and they can provide higher effectiveness than purely mechanical techniques. This applies primarily to: 1) the reed bank zone (BF) and 2) the lower riparian zone (OF) (Figure 19-a). The following techniques apply to the **reed bank zone**:

Reed berms (Figure 19-b), consisting of a combination of reeds and riprap, break wave action, and erosion of banks by currents. Banks should not exceed a 2:1 slope. Riprap is placed to form a berm that extends beyond the surface at mean low-water level, separating the reed bed from the body of water.

Willow jetties (Figure 19-c) can be constructed at the water level to stabilize a cutbank by deflecting the current and by encouraging deposition of sediment. Steps:

1. Dig ditches diagonally to direction of flow, and place fill to form berm downstream from ditch.
2. Set 2-foot willow branches (4 feet may be needed) at 45° angle and 3-inch spacing facing downstream.
3. Weigh down branches with riprap extending beyond water level.

Willow gabions (Figure 19-d) can be used when a hard-edged effect is desired to deflect the eroding flow of water. Live willow branches, pointing downstream, are inserted through the wire mesh when the gabion is packed with stone and an addition of finer materials. Branches need to be long enough to extend through the gabion into the soil of the bank. They also should be placed at an angle back into the slope.

Piling revetment (Figure 19-e) with wire facings is especially suited for the stabilization of cutbanks with deep water. It involves the following steps:

1. Drive heavy timbers (8-12 inch diameter) on 6- to 8-foot centers along bank to be protected to point of refusal or one half-length of pile below maximum scour.
2. Fasten heavy wire fencing to the post and if the streambed is subject to scour, extend it horizontally on the streambed for a distance equal to the anticipated depth of scour and weight with concrete blocks. As scour occurs, this section will drop into place.
3. Pile brush on the bank side of the fence, and plant willow saplings on bank to encourage sediment deposits.

In the **lower riparian zone** (Figure 19-f) (open floodway) bank stabilization efforts should be concentrated on critical areas only. The stabilizing effect of riprap can be supplemented with willows, which will bind soil through their roots and screen the bank. Banks can be paved with stone (set in sand). Willow cuttings in joints need to be long enough to extend to natural soil and should have 2 to 4 buds above surface. Willow branches in riprap should be installed simultaneously. Branches should extend 1 foot into the soil below stone and 1½ feet above ground, pointing downstream.

Willow branch mat revetment (Figure 19-g) takes the following steps to install:

1. Grade slope to approximately 2:1 and excavate a 3-foot ditch at the toe of slope.
2. Lay live willow brush with butts upslope and anchor mat in the ditch below normal waterline by packing with large stones.
3. Drive 3-foot willow stakes 2½ feet on center to hold down brush; connect stakes with No. 9 galvanized wire and cover brush slightly with dirt to encourage sprouting.

Maintenance

- Costs vary according to local availability of labor. However, there are practically no maintenance costs for the vegetation once it is established, since it holds the banks ‘naturally’ as compared to concrete ‘improvement’ that constantly needs repairs.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.

References

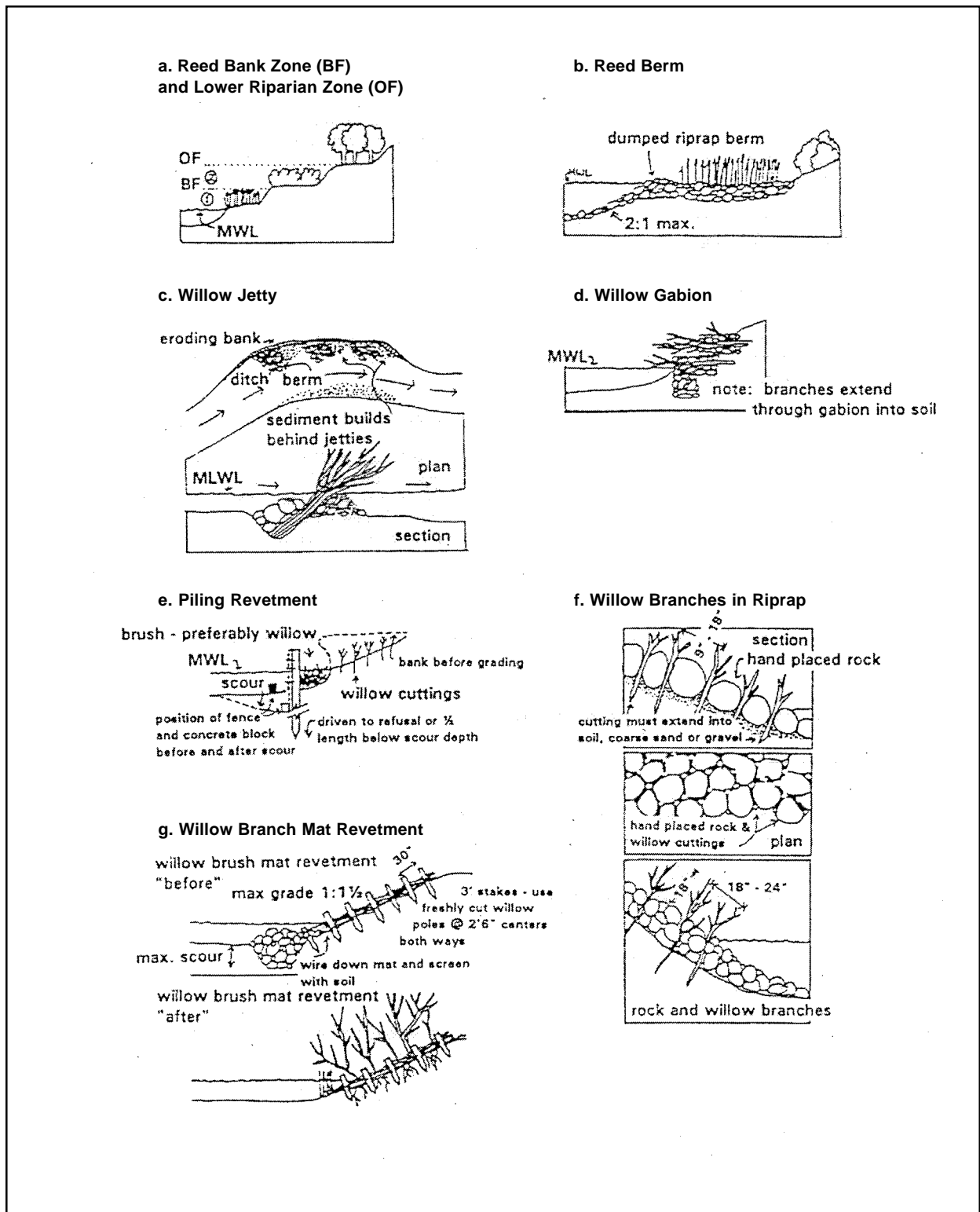
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Figure 19-a, -b, -c, -d, -e, -f and -g. Bioengineering Methods of Streambank Stabilization



BMP E2.90: Structural Streambank Stabilization

Code	Symbol
	

Definition

Methods of stabilizing the banks and streams with permanent structures.

Purpose

To protect streambanks from the erosive forces of moving water, where vegetative or bioengineered methods are insufficient or infeasible.

Conditions Where Practice Applies

Streambank sections, where excessive erosion is anticipated because of highly erodible soils.

Advantages

Permanent structural measures are an effective method of preventing severe streambank erosion.

Disadvantages/Problems

Most types of structural stabilization do not offer any water quality benefits except for the potential for reduced erosion and downstream siltation.

Planning Considerations

Stream channel erosion problems vary widely in type and scale. Many different structural stabilization techniques have been employed with varying degrees of effectiveness. The purpose of this specification is merely to point out some of the practices available and to establish some broad guidelines for their selection and design. Such structures should be planned and designed in advance by a professional engineer licensed in the state of Washington. Many of the practices referenced here involve the use of manufactured products and should be designed and installed in accordance with manufacturer's specifications.

Before selecting a structural stabilization technique, the designer should carefully evaluate the possibility of using vegetative stabilization (BMP E2.80) or bioengineering measures (BMP E2.85) to achieve the desired protection. Vegetative techniques are generally less costly and more compatible with natural stream characteristics, and, in most instances, HPAs from the state Departments of Fisheries and Wildlife may require this method.

Design Criteria

- Design must be prepared based on criteria and input/review from a qualified fisheries biologist.
- Since each reach of channel requiring protection is unique, measures for streambank protection shall be installed according to a plan and adapted to the specific site. Design shall be developed according to the following principles:
 - a. Bottom scour shall be controlled, by either natural or structural means, before any permanent type of bank protection can be considered feasible.
 - b. Stream requirements must be met. These include, but are not necessarily limited to, the following:
 - development limitations imposed by the local government's Sensitive Area Ordinance (if applicable)
 - requirements of the Shoreline Management Act


- permit requirements from State and Federal agencies such as a Hydraulic Project Approval (HPA, Washington Depts. of Fish and Wildlife), Dam Safety (Washington Dept. of Ecology), and Navigation, Shoreline and Section 101 and 404 permits for the Corps of Engineers.
- c. Special attention shall be given to maintaining and improving habitat for fish and wildlife.
- d. Structural measures must be effective for the design flow and be capable of withstanding greater flows without serious damage.
- The following structural streambank stabilization measures may be considered:
 - a. **Riprap** - heavy angular stone placed on the streambank to provide armor protection against erosion.
 - b. **Gabion** - rectangular, pervious, semi-flexible rock-filled wire baskets that can be used to armor streambanks.
 - c. **Reinforced Concrete** - retaining walls or bulkheads used to armor eroding sections of streambank.
 - d. **Log Cribbing** - retaining structure built of logs to protect streambanks from erosion. (Log cribbing can have vegetation inserted between logs.)
 - e. **Grid Pavers** - modular concrete units with interspersed void areas that can be used to armor the streambank while maintaining porosity and allowing the establishment of vegetation.

Maintenance

- Inspections should be made regularly and after each large storm event. Repairs should be made as quickly as possible after the problem occurs.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.

Sediment Retention

BMP E3.10: Filter Fence

Code	Symbol
FF	

Definition

A temporary sediment barrier consisting of a filter fabric stretched across and attached to supporting posts and entrenched. The filter fence is constructed of stakes and synthetic filter fabric with a rigid wire fence backing where necessary for support.

Purpose

1. To intercept and detain **small amounts** of sediment under sheet flow conditions from disturbed areas during construction operations in order to prevent sediment from leaving the site.
2. To decrease the velocity of sheet flows.

Conditions Where Practice Applies

Filter fences must be provided just upstream of the point(s) of discharge of runoff from a site, before the flow becomes concentrated. They may also be required:

1. Below disturbed areas where runoff may occur in the form of sheet and rill erosion; wherever runoff has the potential to impact downstream resources.
2. Perpendicular to minor swales or ditch lines for contributing drainage areas up to one acre in size.

Advantages

- Sediment deposits originating from the development will not damage downstream riparian areas.
- Sediment will not cause damage to fish habitat.

Disadvantages/Problems

- Filter fences are **not** practical where large flows of water are involved, hence the need to restrict their use to drainage areas of one acre or less, and flow rates of less than 0.5 cfs. This flow should not be concentrated; it should be spread out over many linear feet of filter fabric fence.
- Problems may arise from incorrect selection of pore size and/or improper installation.
- Filter fences should not be constructed in streams or used in V-shaped ditches. They are not an adequate method of runoff control for anything deeper than sheet or over-land flow.

Planning Considerations

Laboratory work at the Virginia Highway and Transportation Research Council has shown that silt fences can trap a much higher percentage of suspended sediments than can straw bales. Silt fences are preferable to straw barriers in many cases. However, while the failure rate of silt fences is lower than that of straw barriers, there are many instances locally in which silt fences have been improperly installed. The installation methods outlined here can improve performance.

Fabric Types

There are four types of material used for filter fabric fences; woven slit-film fabric, woven monofilament fabrics, woven composites (of differing materials) and non-woven heat-treated or needle punched fabrics. Slit-film fabrics are made from woven sheets of nonporous polymers. The sheets are very thin but are cut or slit in wider bands to form the threads that are then woven into the fabric. Since slit-film weaves use strands that are quite thin, the resulting woven fabric has little rigidity, and pore spaces are not uniform. Wire fencing must be used as a backing for this type of filter fabric fence. While this type of fabric is generally cheapest and the most widely used, the additional costs of the wire fence installation must be figured in.

Woven monofilament fabrics are made from uniform spun or extruded filaments that are then woven to form the fabric. They are usually thicker and thus more rigid than slit-film fabrics. The pores in monofilament fabrics are regularly spaced and the increased rigidity offers more resistance to pore distortion. The material has a very low flow-through rate. Woven composites are similar in structure but use more than one fiber type.

Non-woven fabrics are made by using either continuous filaments or short staple fibers. These fibers are then bonded together by various processes that can include a needling process that intertwines the fibers physically, or a thermal or chemical bonding operation that fuses adjacent fibers together. The resulting fabric has a random fiber orientation and may have a thickness that ranges from thick felt to a relatively thin fabric.

King County Conservation District recently completed tests on 18 different types of filter fabrics. Their results have been incorporated into the design criteria.

Design Criteria

- The drainage area must be one acre or less or the fence must be used in combination with sediment basin on a larger site.
- Maximum slope steepness on the site (perpendicular to fence line) is 1:1.
- Maximum sheet or overland flow path length to the fence is 100 feet.
- Concentrated flows shall not be greater than 0.5 cfs.
- Selection of a filter fabric is based on soil conditions at the construction site (which affect the apparent opening size (AOS) fabric specification) and characteristics of the support fence (which depend on the choice of tensile strength). The designer shall specify a filter fabric that retains the soil found on the construction site yet will have openings large enough to permit drainage and prevent clogging.
- The material used in a filter fabric fence must have sufficient strength to withstand various stress conditions and the ability to pass flow through must be balanced with the material's ability to trap sediments.
- Non-woven and regular strength slit film fabrics shall be supported with wire mesh. Filter fabric material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0°F. to 120°F.

Selection of the AOS:

1. Because of the properties of soils in the Puget Sound basin, field work must determine the optimum AOS for filter fence installations. Many soils in this area contain both cobbles and fines. If a Soil Conservation Service (SCS) standard soil description is used, (e.g. Alderwood gravelly sandy loam) the AOS specified will not be sufficient to trap the finer particles of soil. Including gravels and larger sizes skews the results

towards an AOS that is too small to capture suspended settleable solids and reduce Total Suspended Solids (TSS). Monofilament and non-woven geotextiles must have a minimum AOS of 70 when used in glacial soils. Composites and slit film fabrics must be extra-strength to perform similarly; in their case the AOS range may be from 40-60. In areas where Mazama ash is plentiful in the soil profile, a larger AOS will be necessary, or, fabric with an AOS of 70 should be used for outwash soils.

2. For all other soil types, the AOS should be determined by first passing soil through a #10 sieve (2.0 mm). Based on the amount of the remaining soil, by weight, which passes through a U.S. standard sieve No. 200, select the AOS to retain 85% of the soil. Where direct discharge to a stream, lake, or wetland will occur, then the AOS shall be no larger than Standard Sieve No. 100.

Standard Notes

In addition to the Technical Information Report required when preparing an erosion and sediment control plan, add the following notes to the Filter Fabric Fence Detail (Fig-20):

- a. The filter fabric shall be purchased in a continuous roll cut to the length of the barrier to avoid use of joints. When joints are necessary, filter cloth shall be spliced together only at a support post, with a minimum 6-inch overlap, and both ends securely fastened to the post.
- b. Posts shall be spaced a maximum of 6 feet apart and driven securely into the ground a minimum of 30 inches (where physically possible).
- c. A trench shall be excavated approximately 8 inches wide and 12 inches deep along the line of posts and upslope from the barrier. The trench shall be constructed to follow the contour.
- d. When slit film filter fabric is used, a wire mesh support fence shall be fastened securely to the upslope side of the posts using heavy-duty wire staples at least 1 inch long, tie wires or hog rings. The wire shall extend into the trench a minimum of 4 inches and shall not extend more than 36 inches above the original ground surface.
- e. Slit film filter fabric shall be wired to the fence, and 20 inches of the fabric shall extend into the trench. The fabric shall not extend more than 36 inches above the original ground surface. Filter fabric shall not be stapled to existing trees. Other types of fabric may be stapled to the fence.
- f. When extra-strength or monofilament fabric and closer post spacing are used, the wire mesh support fence may be eliminated. In such a case, the filter fabric is stapled or wired directly to the posts with all other provisions of Standard Note “e” applying. Extra care should be used when joining or overlapping these stiffer fabrics.
- g. Local governments may specify the use of properly compacted native material. In many instances, this may be the preferred alternative because the soil forms a more continuous contact with the trench below, and use of native materials cuts down on the number of trips that must be made on and off-site. If gravel is used instead, the trench shall be backfilled with ¾-inch minimum diameter washed gravel. Care must be taken when using gravel to ensure good contact between the fabric and the trench bottom to prevent undercutting.
- h. Filter fabric fences shall be removed when they have served their useful purpose, but not before the upslope area has been permanently stabilized. Retained sediment must be removed and properly disposed of, or mulched and seeded.

Maintenance

- Inspect immediately after each rainfall, and at least daily during prolonged rainfall. Repair as necessary.
- Sediment must be removed when it reaches approximately one-third the height of the fence.
- Any sediment deposits remaining in place after the filter fence is no longer required shall be spread to conform to the existing grade, prepared and seeded.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

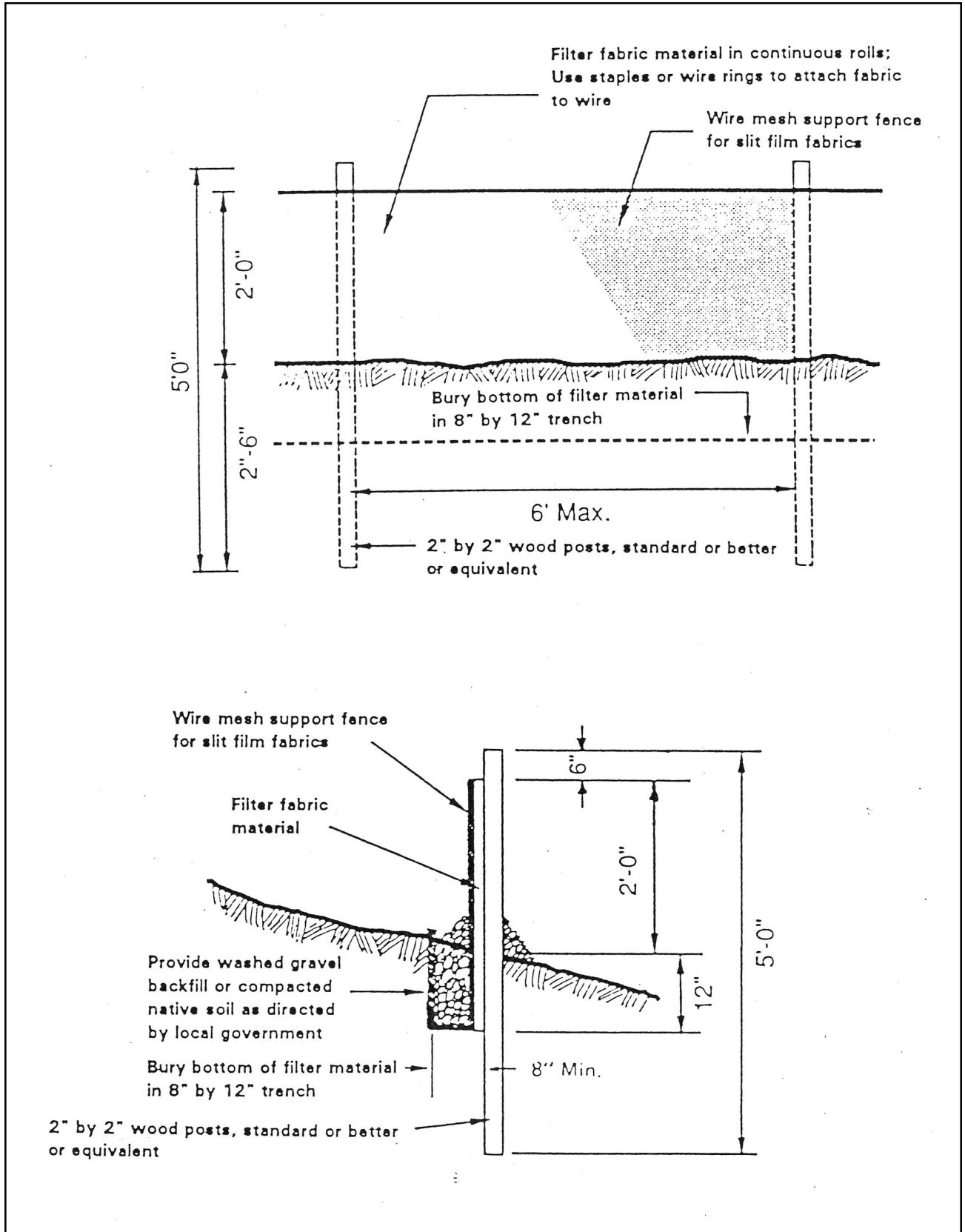
References

Kulzer, Louise, Considerations for Using Geotextiles in Silt Fence Applications, Metro Technology Transfer Publication, Nov., 1988.



Varney, Dick, An Evaluation of Geotextiles as Filter Fabric Fence Using Local Soils for Planning and Engineering, King County Conservation District, Sept., 1991.

Varney, Dick, personal communication, March 4, 1992.

Figure 20. Filter Fabric Fence Detail



BMP E3.15: Straw Bale Barrier

Code	Symbol
	

Definition

A temporary sediment barrier consisting of a row of entrenched and anchored straw bales.

Purpose

1. To intercept and detain small amounts of sediment from disturbed areas of limited extent.
2. To decrease the velocity of sheet flows and low-to-moderate level channel flows.

Conditions Where Practice Applies

- Below disturbed areas subject to sheet and rill erosion.
- Where the size of the drainage area is no greater than 1/4 acre per 100 feet of barrier length; the maximum slope length behind the barrier is 100 feet; and the maximum slope gradient behind the barrier is 50% (2:1).
- In minor swales or ditch lines where the maximum contributing drainage area is no greater than 2 acres.
- Where a barrier is required for less than 3 months.
- Under no circumstances should straw bale barriers be constructed in live streams or in swales where there is the possibility of a washout.

Advantages

When properly used, straw bale barriers are an inexpensive method of sediment control.

Disadvantages/Problems

- Straw bale barriers are easy to misuse and can become contributors to a sediment problem instead of a solution.
- It is difficult to tell if bales are securely seated and snug against each other.

Planning Considerations

Based on observations made locally and in Virginia, Pennsylvania, Maryland, and other parts of the nation, straw bale barriers have not been as effective as many users had hoped they would be. There are three major reasons for such ineffectiveness.

1. Improper use of straw bale barriers has been a major problem. Straw bale barriers have been used in streams and drainageways where high water velocities and volumes have destroyed or impaired their effectiveness.
2. Improper placement and installation of the barriers, such as staking the bales directly to the ground with no soil seal or entrenchment, has allowed undercutting and end flow. This has resulted in additions to, rather than removal of, sediment from runoff waters.
3. Inadequate maintenance lowers the effectiveness of these barriers. For example, trapping efficiencies of carefully installed straw bale barriers on one project in Virginia dropped from 57% to 16% in one month due to lack of maintenance.

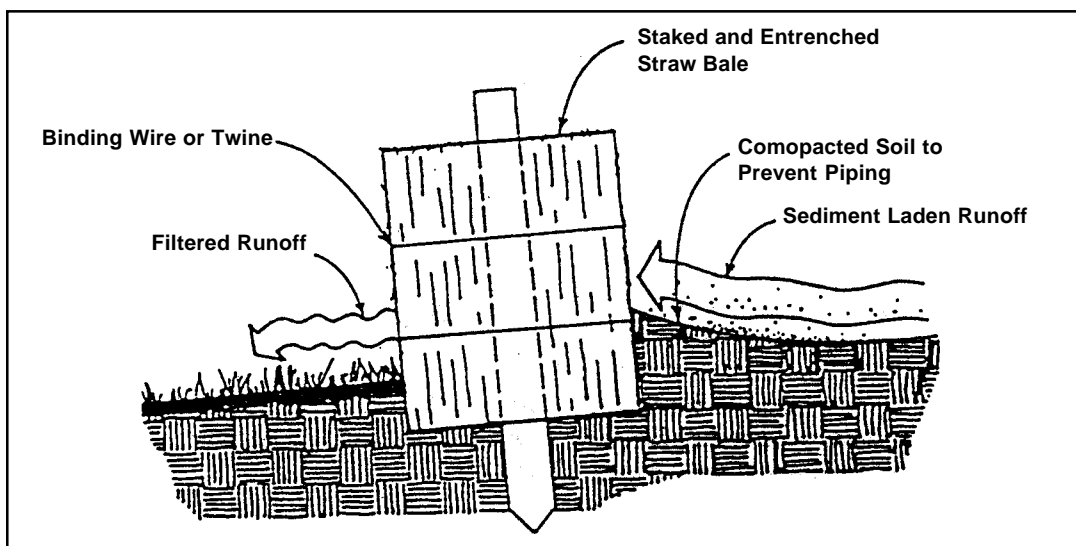
There are serious questions about the continued use of straw bale barriers as they are presently installed and maintained. Averaging approximately \$4.00 per linear foot, the

thousands of straw bale barriers used annually represent sufficient expense that optimum installation procedures should be emphasized. If such procedures are carefully followed, straw bale barriers can be quite effective. Therefore, continued designation of straw bale barriers as a BMP will be contingent upon significant improvement in the installation and maintenance procedures applied to their use.

Design Criteria

- A formal design is not required.
- **Sheet Flow Applications**
 1. Bales shall be placed in a single row, lengthwise **on** the contour, with ends of adjacent bales **tightly** abutting one another.
 2. All bales shall be either wire-bound or string-tied. Straw bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings (Figure 21).
 3. The barrier shall be entrenched and backfilled. A trench shall be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. The trench must be deep enough to remove all grass and other material that might allow underflow. After the bales are staked and chinked (filled by wedging), the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to 4 inches against the uphill side of the barrier.
 4. At least 2 stakes or re-bars driven through the bale shall securely anchor each bale. The first stake in each bale shall be driven toward the previously laid bale to force the bales together. Stakes or re-bars shall be driven deep enough into the ground to securely anchor the bales. Stakes should not extend above the bales but instead should be driven in flush with the top of the bale for safety reasons.
 5. The gaps between the bales shall be chinked (filled by wedging) with straw to prevent water from escaping between the bales. Loose straw scattered over the area immediately uphill from a straw bale barrier tends to increase barrier efficiency. Wedging must be done carefully in order not to separate the bales.
 6. Inspection shall be frequent and repair or replacement shall be made promptly as needed.
 7. Straw bale barriers shall be removed when they have served their usefulness, but not before the upslope areas have been permanently stabilized.

Figure 21.
Cross-section of
Properly Installed
Straw Bale Barrier

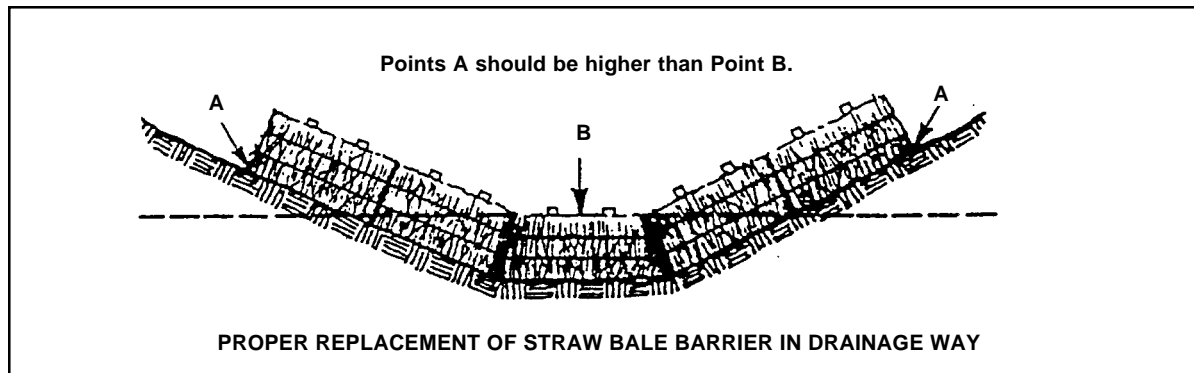
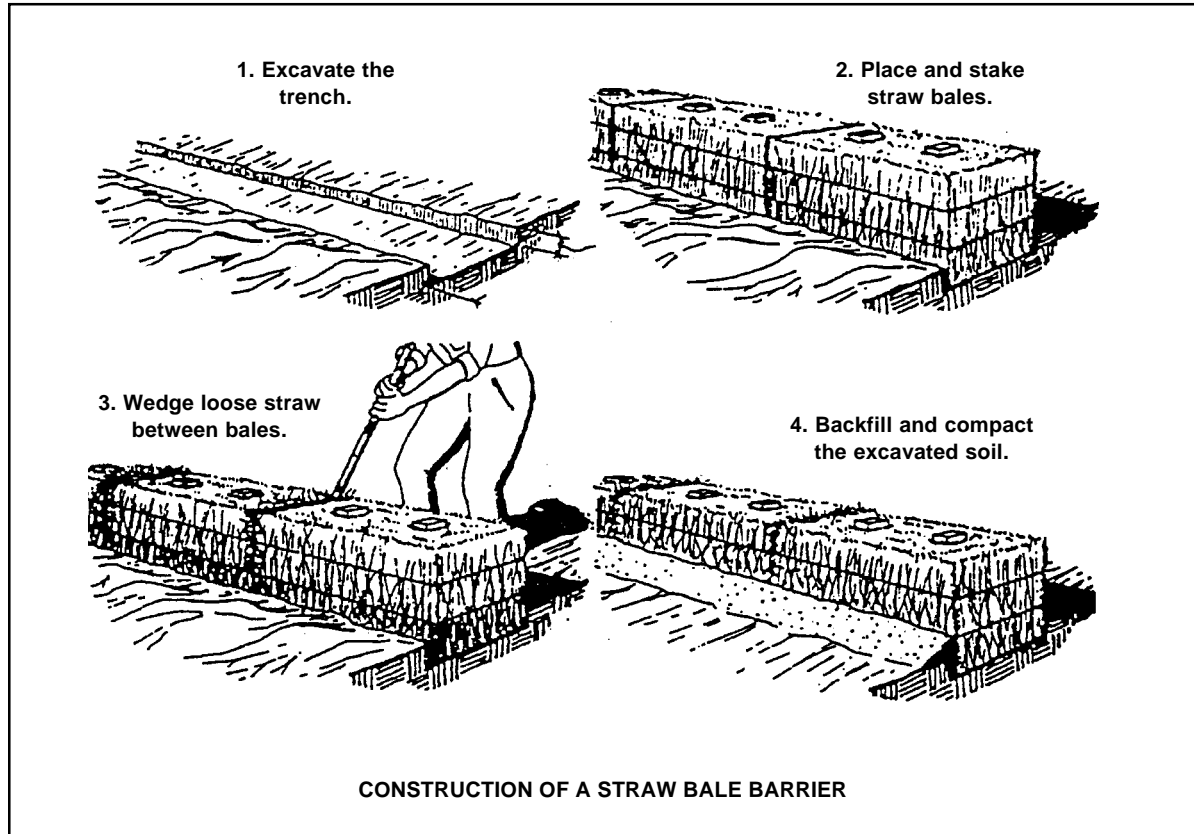


- Channel Flow Applications
 1. Bales shall be placed in a single row, lengthwise, oriented perpendicular to the contour, with ends of adjacent bales tightly abutting one another.
 2. The remaining steps for installing a straw bale barrier for sheet flow applications apply here, with the following addition.
 3. The barrier shall be extended to such a length that the bottoms of the end bales are higher in elevation than the top of the lowest middle bale (Figure 23) to assure that sediment-laden runoff will flow either through or over the barrier but not around it.



Maintenance

- Inspect straw bale barriers immediately after each runoff-producing rainfall and at least daily during prolonged rainfall.
- Replace damaged bales and make repairs to barriers needed to stop end runs and undercutting beneath bales promptly.
- Sediment deposits shall be removed after each runoff-producing rainfall or when the level of deposition reaches approximately one-half the height of the barrier.
- Any sediment deposits remaining in place after the straw bale barrier is no longer required shall be dressed to conform to the existing grade, prepared and seeded.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

Figure 22. Proper Installation of Straw Bale Barrier



BMP E3.20: Brush Barrier

Code	Symbol
	

Definition

A temporary sediment barrier constructed at the perimeter of a disturbed area from materials obtained from clearing and grubbing the site.

Purpose

To intercept and retain sediment from limited disturbed areas.

Conditions Where Practice Applies

Below disturbed areas of less than one quarter acre that are subject to sheet and rill erosion, where enough brush material is available for construction of such a barrier. Note: This does not replace a sediment trap or pond.

Advantages

Brush barriers can often be constructed using materials found on-site.

Problems

None

Planning Considerations

Organic litter and spoil material from site clearing operations is usually burned or hauled away to be dumped elsewhere. Much of this material can be used effectively on the construction site itself. During clearing and grubbing operations, equipment can push or dump the mixture of limbs, small vegetation, and root mat along with minor amounts of soil and rock into windrows along the toe of a slope where erosion and accelerated runoff are expected. Anchoring a filter fabric over the berm enhances the filtration ability of the barrier. Because brush barriers are fairly stable and composed of natural materials, maintenance requirements are small. Material containing large amounts of wood chips should not be used because of the potential for leaching from the chips.

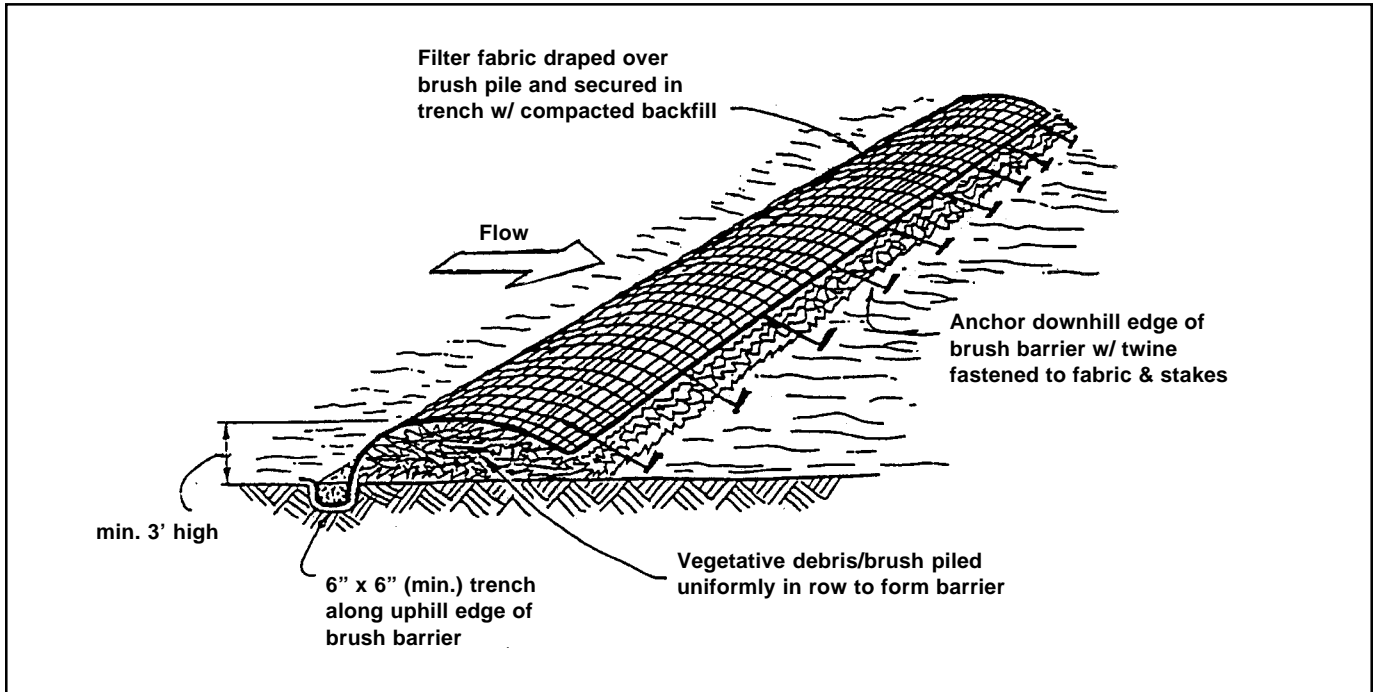
Design Criteria

- Height 3 feet (minimum) to 5 feet (maximum).
- Width 5 feet at base (minimum) to 15 feet (maximum).
- Filter fence fabric anchored over the brush barrier will enhance its filtration capacity.
- Further design details are illustrated in Figure 23.



Maintenance

- Brush barriers generally require little maintenance, unless there are very heavy deposits of sediment. Occasionally, tearing of the fabric may occur.
- When the barrier is no longer needed, the fabric can be removed to allow natural establishment of vegetation within the barrier, if desired. The barrier will rot away over time.

Figure 23. Brush Barrier



BMP E3.25: Gravel Filter Berm

Code	Symbol
	

Definition

A raised gravel berm or mound constructed on rights-of-way or traffic areas within a construction site.

Purpose

To keep sediment away from traffic areas by filtering runoff through gravel or crushed rock.

Conditions Where Practice Applies

Where a temporary measure is needed to retain sediment from rights-of-way or in traffic areas on construction sites.

Advantages

This is a very efficient method of sediment removal.

Disadvantages/Problems

This BMP is more expensive to install than are other BMPs that use materials found on-site.

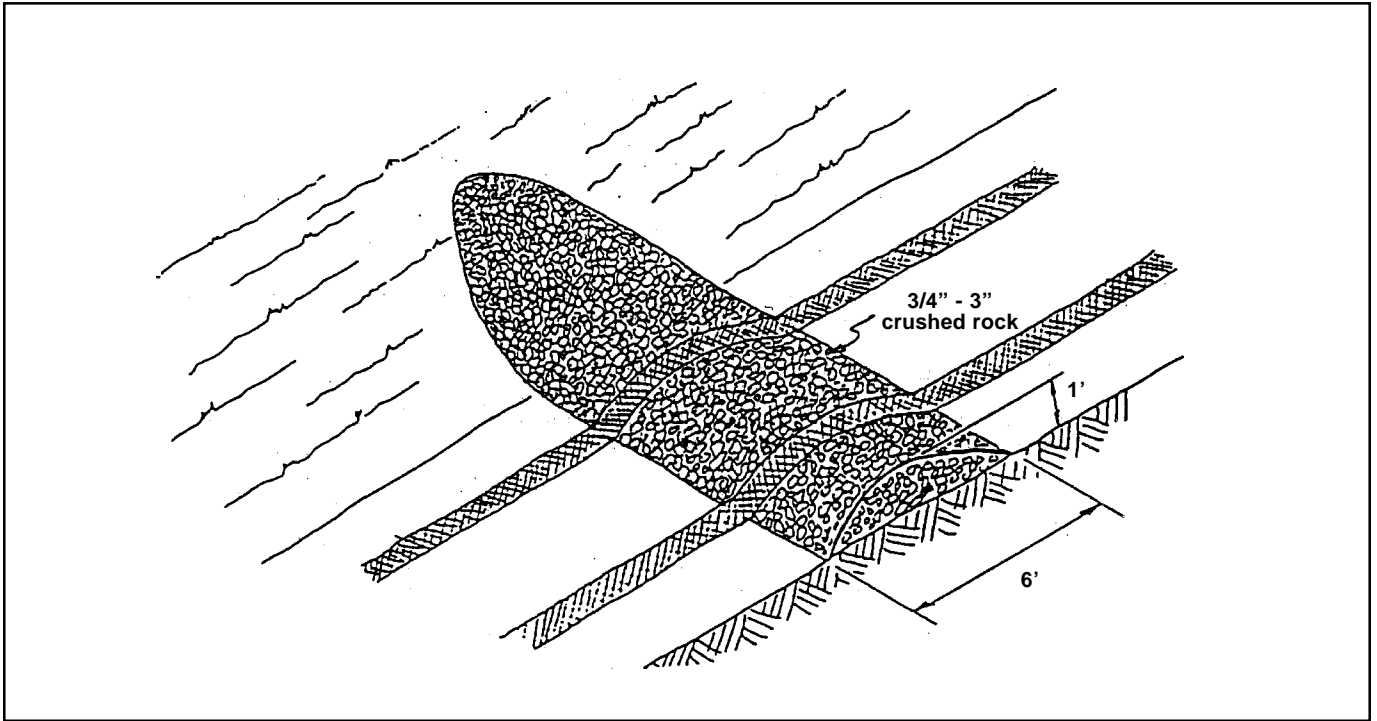
Design Criteria

- Berm material shall be $\frac{3}{4}$ to 3 inches in size, washed, well-graded gravel or crushed rock with less than 5% fines (Figure 24).
- Spacing of berms:
 - every 300 feet on slopes less than 5%
 - every 200 feet on slopes between 5 and 10%
 - every 100 feet on slopes greater than 10%
- Berm dimensions:
 - 1 foot high with 3:1 side slopes
 - 8 linear feet per 1 cfs runoff based on the 10-year, 24-hour design storm.


Maintenance

- Regular inspection is required; sediment shall be removed and filter material replaced when it becomes clogged.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.

Figure 24. Gravel Filter Berm



BMP E3.30: Storm Drain Inlet Protection

Code	Symbol
IP	

Definition

A sediment filter or an excavated impounding area around a storm drain, drop inlet, or curb inlet.

Purpose

To prevent sediment from entering storm drainage systems prior to permanent stabilization of the disturbed area.

Conditions Where Practice Applies

Where storm drain inlets are to be made operational before permanent stabilization of the disturbed drainage area. Different types of structures are applicable to different conditions:

- Filter Fabric Fence** - applicable where the inlet drains a relatively small (less than 1 acre) flat area (less than 5% slope) (see Figure 26). Do not place fabric under grate as the collected sediment may fall into the drain when the fabric is retrieved. This practice cannot easily be used where the area is paved because of the need for driving stakes to hold the material.
- Concrete Block and Gravel Filter** - applicable where heavy flows (greater than 0.5 cfs) are expected (Figure 26).
- Gravel and Wire Mesh Filter** - applicable where flows greater than 0.5 cfs are expected and construction traffic may occur over the inlet (Figure 27.)

Advantages

Inlet protection prevents sediment from entering the storm drain system and clogging it.

Disadvantages/Problems

Sediment removal may be difficult, especially under high flow conditions.

Planning Considerations

Storm sewers that are made operational before their drainage area is stabilized can convey large amounts of sediment to natural drainageways. In cases of extreme sediment loading, the storm sewer itself may clog and lose a major portion of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

Several types of inlet filters and traps have different applications that depend on site conditions and type of inlet. Other innovative techniques for accomplishing the same purpose are encouraged, but only after specific plans and details are submitted to and approved by the Plan Approving Authority of the local government (see Design Criteria for the description of a new method currently under development by EMCON Northwest, Inc.). Note that these various inlet protection devices are for drainage areas of less than one acre. Runoff from larger disturbed areas should be routed through a Temporary Sediment Trap or Pond (see BMPs E3.35, E3.40).

The best way to prevent sediment from entering the storm sewer system is to stabilize the site as quickly as possible, preventing erosion and stopping sediment at its source.

Design Criteria

- Grates and spaces of all inlets must be secured to prevent seepage of sediment-laden water.
- All inlet protection measures should include sediment sumps of 1 to 2 feet in depth, with 2:1 side slopes (Figure 25).
- Installation requirements for filter fabric fence:
 - a. Place 2 inch by 2 inch wooden stakes around the perimeter of the inlet a maximum of 3 feet apart and drive them at least 8 inches into the ground. The stakes must be at least 3 feet long.
 - b. Excavate a trench approximately 8 inches wide and 12 inches deep around the outside perimeter of the stakes.
 - c. Staple the filter fabric (for materials and specifications, see BMP E3.10, Filter Fence) to wooden stakes so that 32 inches of the fabric extends out and can be formed into the trench. Use heavy-duty wire staples at least ½ inch in length.
 - d. Backfill the trench on top of the fabric with ¾ inch or less washed gravel all the way around.
- Installation requirements for concrete block and gravel filter:
 - a. Place wire mesh over the drop inlet so that the wire extends a minimum of 1 foot beyond each side of the inlet structure. Use hardware cloth or comparable wire mesh with one-half inch openings. If more than one strip is necessary, overlap the strips. Place filter fabric over the wire mesh.
 - b. Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, so that the open ends face outward, not upward. The ends of adjacent blocks should abut. The height of the barrier can be varied, depending on design needs, by stacking combinations of blocks that are 4 inches, 8 inches, and 12 inches wide. The row of blocks should be at least 12 inches but no greater than 24 inches high (Figure 26).
 - c. Place wire mesh over the outside vertical face (open end) of the concrete blocks to prevent stone from being washed through the blocks. Use hardware cloth or comparable wire mesh with 1/2-inch openings.
 - d. Pile washed stone against the wire mesh to the top of the blocks. Use ¾ to 3 inch gravel.
- Installation procedure for gravel and wire mesh filter:
 - a. Place wire mesh over the drop inlet so that the wire extends a minimum of 1 foot beyond each side of the inlet structure. Use hardware cloth or comparable wire mesh with 1/2-inch openings. If more than one strip of mesh is necessary, overlap the strips. Place filter fabric over wire mesh.
 - b. Extend the filter fence/wire mesh beyond the inlet opening at least 18 inches on all sides. Place ¾ to 3-inch gravel over the filter fabric/wire mesh. The depth of the gravel should be at least 12 inches over the entire inlet opening (see Figure 27.)

Experimental Inlet Protection BMP

Catchbasin Filter System

A number of local manufacturers have recently developed catchbasin filters that prevent sediments and other contaminants from entering storm drainage systems. The catchbasin filter is inserted in the catchbasin just below the grating. The catchbasin filter is equipped with a sediment trap and up to three layers of a filter material (see Figure 29). This type of system may not be applicable in all catchbasins but would work well at construction sites, industrial facilities, service stations, marinas/boatyards, etc.

During research and development of the catchbasin filter, it was found that particulates as small as 15 microns are retained by the filter. Additionally, high levels of particulate heavy metals, oil and grease and TSS have been removed at both industrial facilities and construction sites. This system would be useful in small drainage areas, and for treatment of highly turbid runoff prior to discharge.



Please note that this information is presented for informational purposes only. While this technology appears to be an effective method of controlling some types of pollutants, the City is not in a position to confirm or deny its efficacy at this time.

Maintenance

- For systems using filter fabric: inspections should be made on a regular basis, especially after large storm events. If the fabric becomes clogged, it should be replaced. Sediment should be removed when it reaches approximately one-half the height of the fence. If a sump is used, sediment should be removed when it fills approximately one half the depth of the hole.
- For systems using stone filters: If the stone filter becomes clogged with sediment, the stones must be pulled away from the inlet and cleaned or replaced. Since cleaning of gravel at a construction site may be difficult, an alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

Figure 25. Filter Fabric Fence Inlet Filter

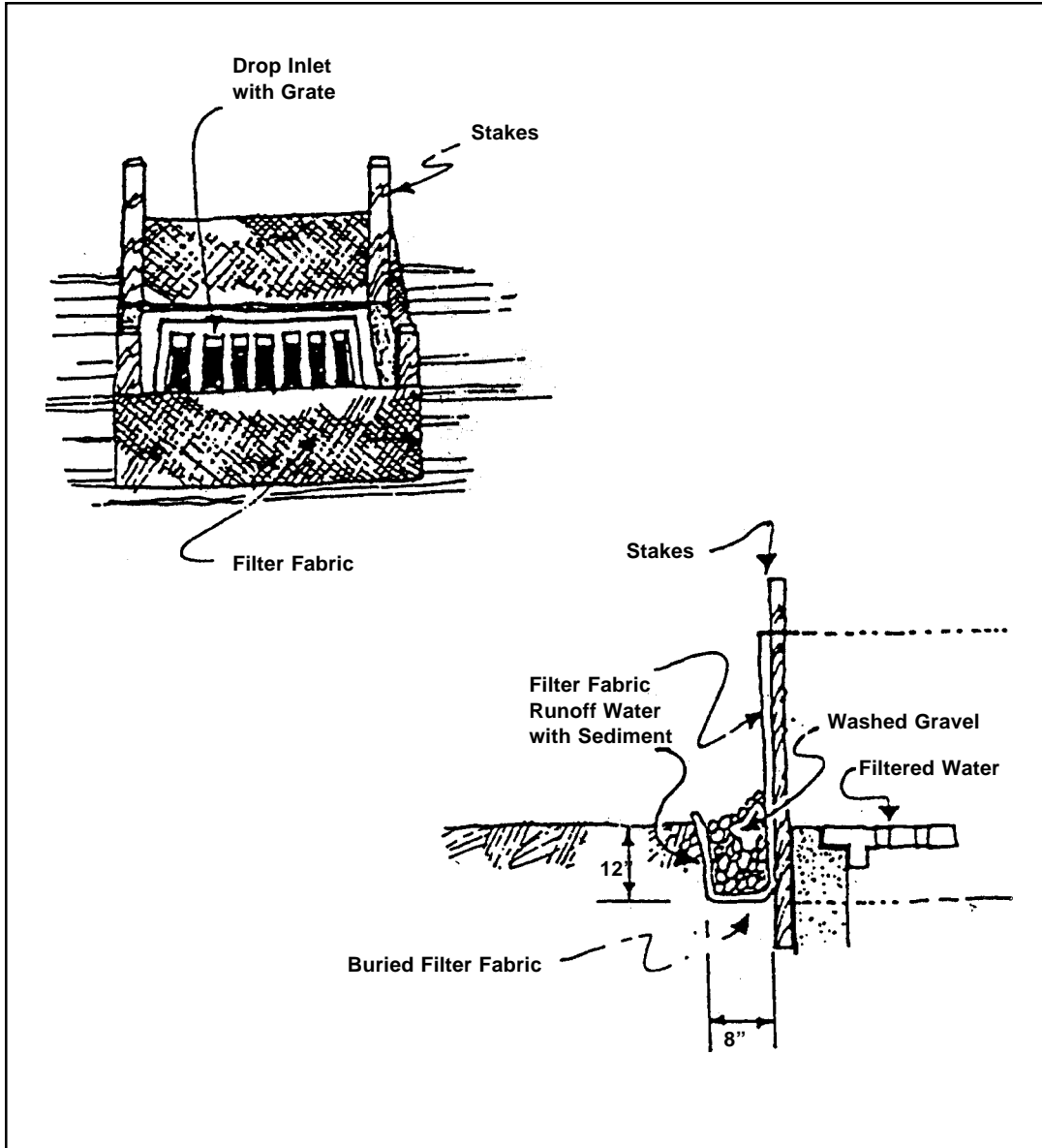


Figure 26. Block and Gravel Filter

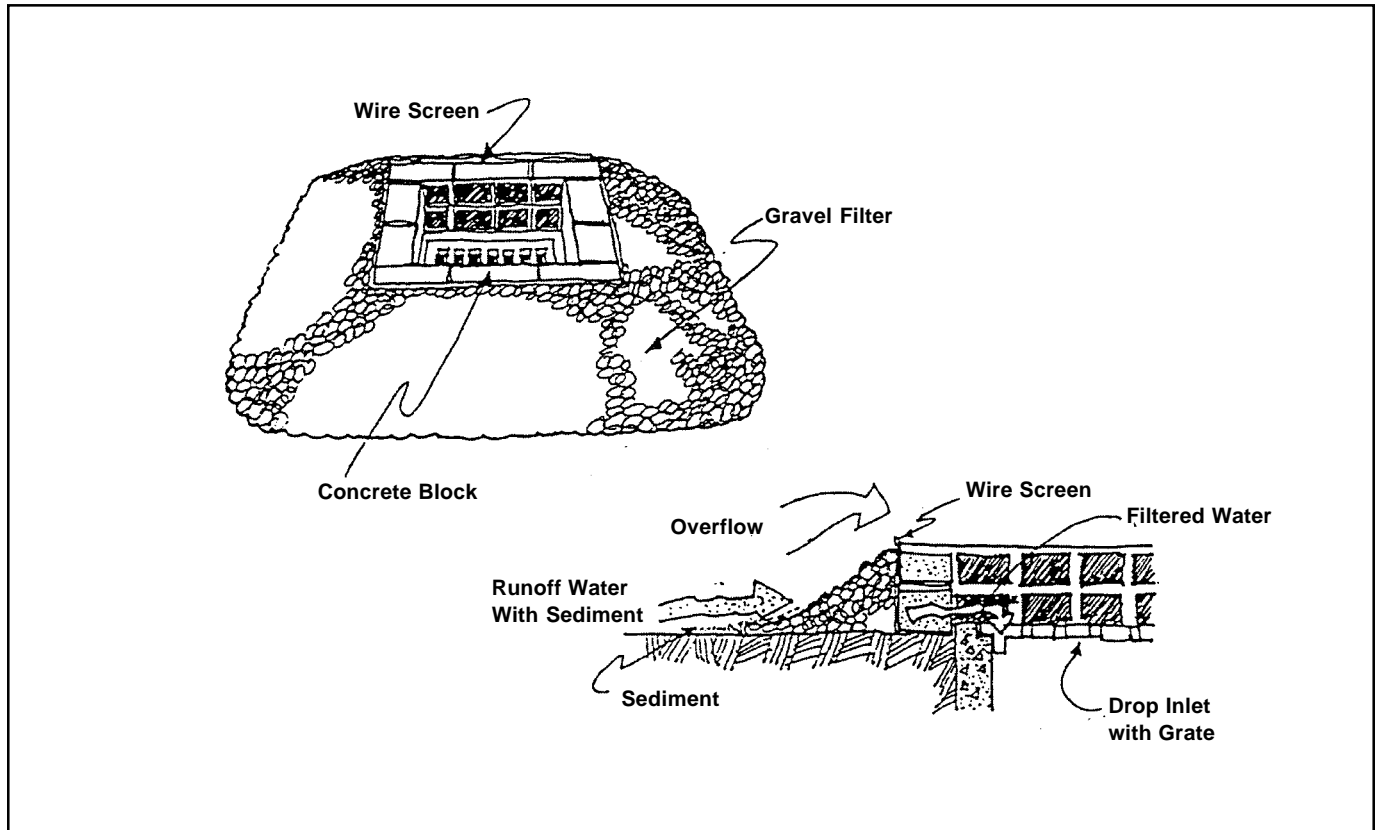


Figure 27. Gravel and Wire Mesh Filter

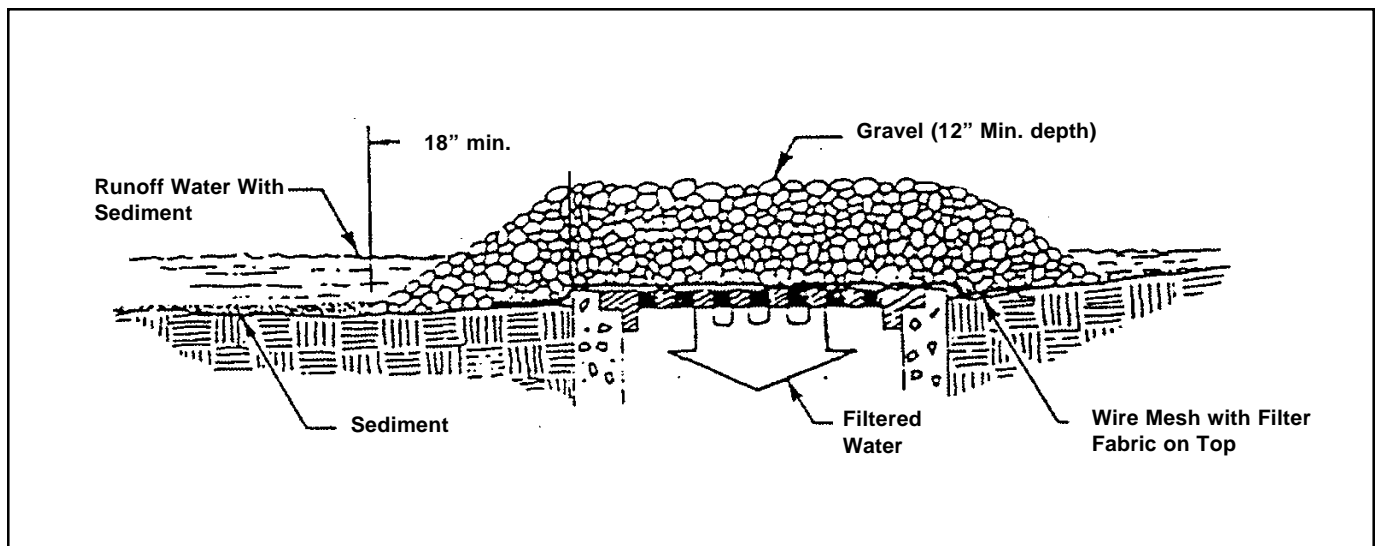
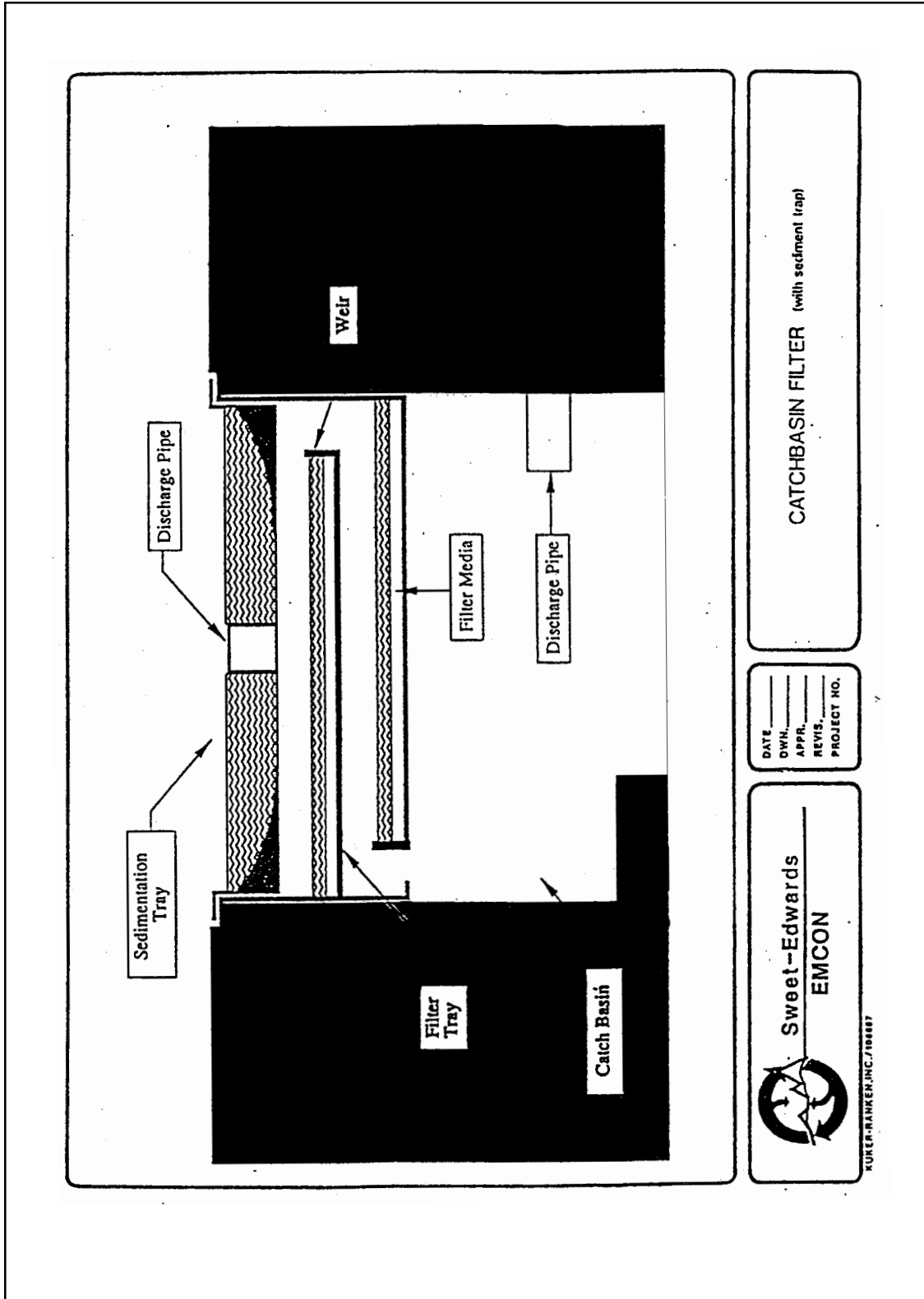




Figure 28. Experimental Catchbasin Filter with Sediment Trap



BMP E3.35: Sediment Trap

Code	Symbol
	

Editor's Note

It is important to understand that sizing is perhaps less important for these BMPs (because of their temporary nature) than is constant maintenance. Inspections must be made and sediment removed regularly for either of these BMPs to function well.

Definition

A small temporary ponding area, with a gravel outlet, formed by excavation and/or by constructing an earthen embankment.

Purpose

To collect and store sediment from sites cleared and/or graded during construction. It is intended for use on relatively small building areas, with no unusual drainage features, and projected quick build-out time. It should help in reducing silt-laden runoff. This silt-laden runoff clogs off-site conveyance systems and destroys habitat, particularly in streams. The trap is a **temporary** measure (with a design life of approximately 6 months) and is to be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

Conditions Where Practice Applies

Proposed building sites where the tributary drainage area is less than **3 acres**.

Advantages

- Downstream riparian properties will not be damaged by sediment deposits originating from that development.
- Sediment deposits downstream will not reduce the capacity of the stream channel.
- Sediment will not cause the clogging of downstream impoundments and other facilities.

Disadvantages/Problems

- Serves only limited areas.
- Sediment traps (and ponds, see BMP E3.40) are only practically effective in removing sediment down to about the medium silt size fraction. Runoff with sediment of finer grades (fine silt and clay) will pass through untreated, emphasizing the need to control erosion to the maximum extent first.

Planning Considerations

Sediment traps should be used only for small drainage areas. If the contributing drainage area is greater than 3 acres, refer to Sediment Ponds (see BMP E3.40), or subdivide the catchment area (see Figure 29).

Sediment must be periodically removed from the trap. Plans shall detail how this sediment is to be disposed of, such as by use in fill areas on-site, or removal to an approved off-site dump. Sediment traps, along with other perimeter controls, shall be installed before any land disturbance takes place in the drainage area.

Safety

See Sediment Ponds (BMP E3.40).

Design Criteria

The sediment trap may be formed completely by excavation or by construction of a compacted embankment. It shall have a 1.5 foot deep sump for sediment storage. The outlet shall be a weir/spillway section, with the area below the weir acting as a filter for sediment and the upper area as the overflow spillway depth.

- See Figures 30 and 31 for details.
- The temporary sediment trap volume can be found by computing the detention volume required for the 2-year, 24-hour design storm. Side slopes should not exceed 3:1. After determining the necessary volume, size the trap by adding an additional 1½ feet for sediment accumulation to the volume computed using the 2-year, 24-hour design storm.
- **To complete the design of the temporary sediment trap:**
 - a. Figures 30 and 31 may be useful in designing the sediment trap.
 - b. A 3:1 aspect ratio between the trap length and width of the trap is desirable. Length is defined as the average distance from the inlet to the outlet of the trap. This ratio is included in the computations for Figure 30 for the surface area at the interface between the settling zone and sediment storage volume.
 - c. Determine the bottom and top surface area of the sediment storage volume to be provided (see Figure 31) using 1½ feet depth for sediment storage and 3:1 side slope from the bottom of the trap. Note the trap bottom should be level.
 - d. Determine the total trap dimensions by adding the depth required for the 2-year, 24-hour design storm above the surface of the sediment storage volume, while not exceeding 3:1 side slopes (see Figure 31).

Maintenance

- The sediment trap must be **continually** monitored and **regularly** maintained. The size of the trap is less important to its effectiveness than is regular sediment removal. Sediment should be removed from the trap when it reaches approximately one foot in depth (assuming a 1½ foot sediment accumulation depth). Regular inspections should be made and additional inspections should be made after each large runoff-producing storm.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

Figure 29. ESC Structural Practices

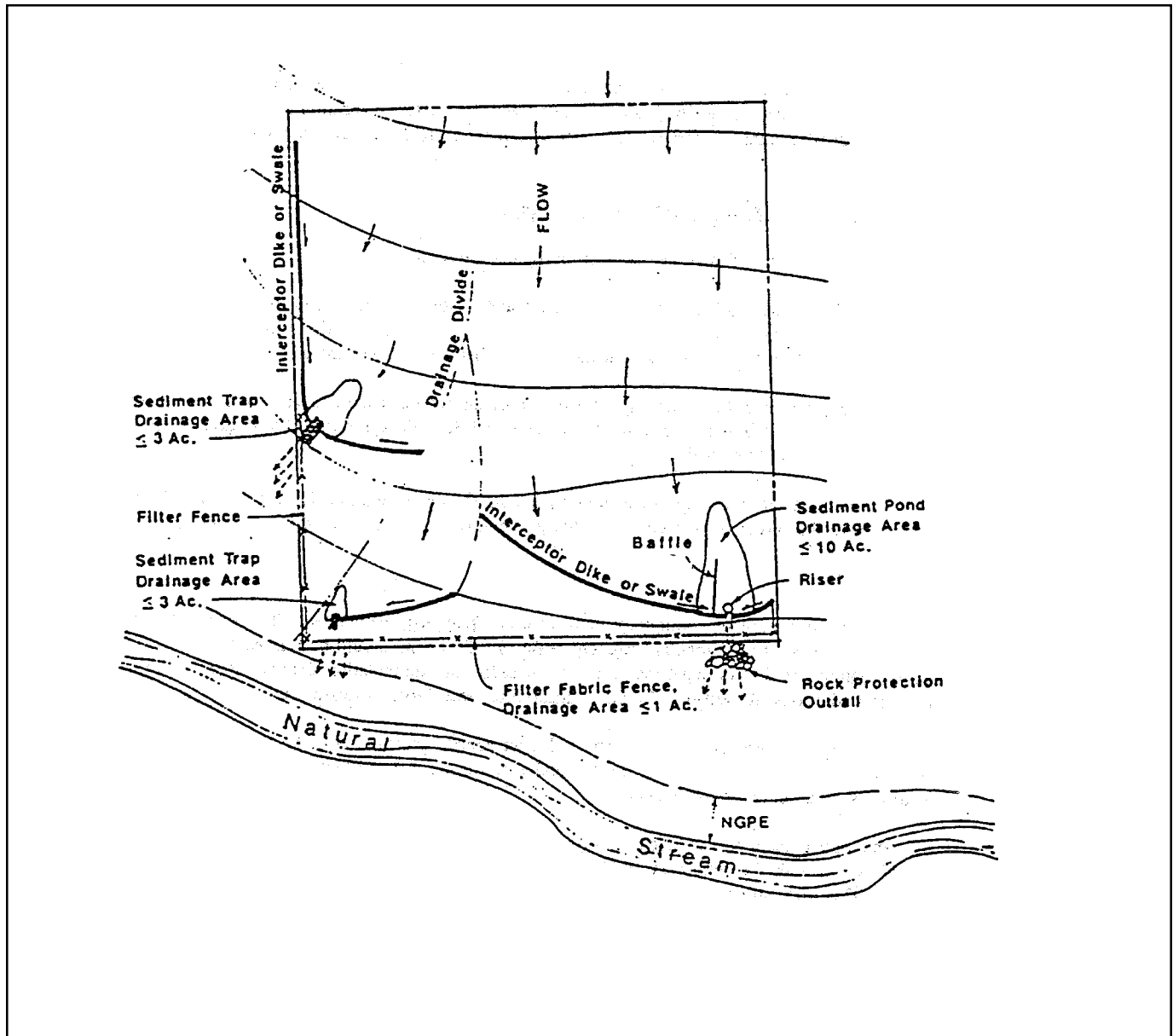
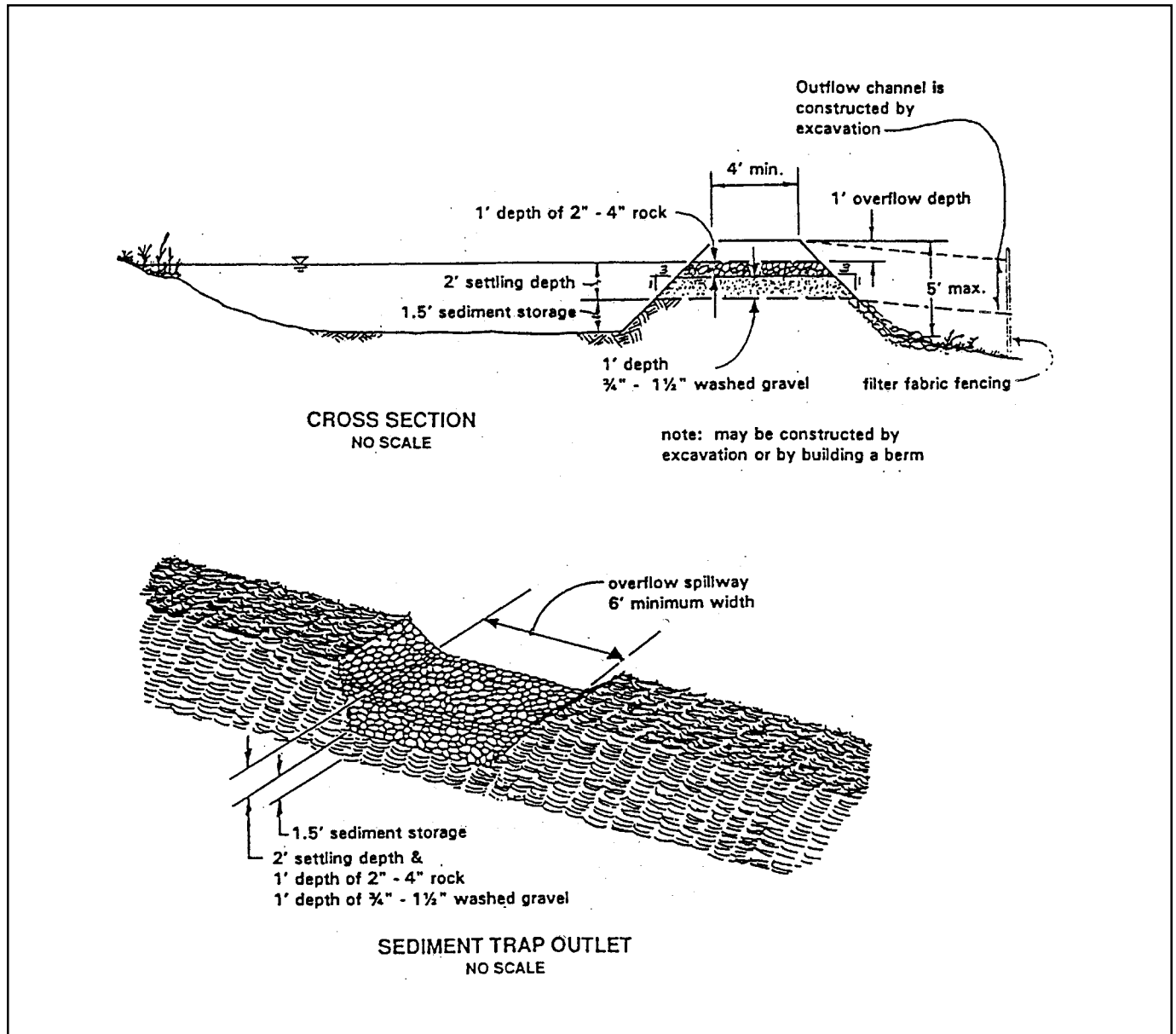



Figure 30. Sediment Trap



BMP E3.40: Temporary Sediment Pond (or Basin)

Code	Symbol
SB	

Editor's Note:

It is important to understand that sizing is perhaps less important for these BMPs (because of their temporary nature) than is constant maintenance. Inspections must be made and sediment removed regularly for either of these BMPs to function well.

Definition

A temporary basin with a controlled stormwater release structure formed by constructing an embankment of compacted soil across a drainageway, or other suitable locations.

Purpose

To collect and store sediment from sites cleared and/or graded during construction or for extended periods of time before reestablishment of permanent vegetation and/or construction of structures. It is intended to help prevent erosion on the site, which results in silt-laden runoff. The basin is a temporary measure (with a design life less than 1 year) and is to be maintained until the site area is permanently protected against erosion.

Conditions Where Practice Applies

Proposed construction sites where the tributary drainage is less than 10 acres.

Safety

Sediment traps and ponds must be installed only on sites where failure of the structure would not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. Also, sediment traps and ponds are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to. If fencing of the pond is required, the type of fence and its location shall be shown on the ESC plan.

Advantages

Because of additional detention time, sediment ponds may be capable of trapping smaller sediment particles than traps. However, they are most effective when used in conjunction with other BMPs such as seeding or mulching.

Disadvantages/Problems

- Ponds may become an “attractive nuisance” and care must be taken to adhere to all safety practices.
- Sediment ponds are only practically effective in removing sediment down to about the medium silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) will pass through untreated emphasizing the need to control erosion to the maximum extent first.

Planning Considerations

Effectiveness. Sediment basins are at best only 70-80 % effective in trapping sediment that flows into them. Therefore, they should be used in conjunction with erosion control practices such as temporary seeding, mulching, diversion dikes, etc. to reduce the amount of sediment flowing into the basin. Sediment basins are most effective when designed with a series of chambers.

Location. To improve the effectiveness of the basin, it should be located so as to intercept the largest possible amount of runoff from the disturbed area. The best locations are

generally low areas below disturbed areas. Drainage into the basin can be improved by the use of diversion dikes and ditches. The basin must not be located in a stream but should be located to trap sediment-laden runoff **before** it enters the stream. The basin should **not** be located where its failure would result in the loss of life or interruption of the use or service of public utilities or roads.

Multiple Use. Sediment basins may be designed as permanent structures to remain in place after construction is completed for use as stormwater detention ponds. Wherever these structures are to become permanent, or if they exceed the size limitations of the design criteria, they must be designed as permanent ponds by a professional engineer licensed in the State of Washington.

Design Criteria

The sediment pond may be formed by partial excavation and/or by construction of a compacted embankment. It may have one or more inflow points carrying polluted runoff. Baffles to spread the flow throughout the basin should be included (Figure 32). A securely anchored riser pipe is the principal discharge mechanism along with an emergency overflow spillway. The riser pipe shall be solid with two 1-inch diameter dewatering holes located at the top of the sediment storage volume on opposite sides of the riser pipe as shown in Figure 32. Outlet protection is provided to reduce erosion at the pipe outlet.

- The sediment pond volume is the sum of the sediment storage volume (3 feet in depth) plus a settling volume of not less than 2 feet in depth. The sediment depth is computed based on the basin surface area required to settle out the design particle at the design inflow rate.

Computing the settling zone volume: The settling zone volume may be approximated by assuming a 2 foot depth above the sediment storage volume and extending the 3:1 side slopes as necessary, or by computing the precise volume as outlined below. The maximum settling zone depth shall be 4 feet.

a. Pond surface area

The settling zone volume is determined by the pond surface area which is computed using the following equation: $(SA) = 1.2Q_{10} / V_{sed}$

Where:

$Q_{10} =$	design inflow based on the peak discharge from a 10-year, 24-hour duration design storm event from the tributary drainage area.
$V_{sed} =$	the settling velocity of the design soil particle. The design particle chosen is medium silt (0.02 mm) (1) This has a settling velocity (V_{sed}) of 0.00096 ft/sec. Note that for the relatively common sandy loam soils found in the Puget Sound basin, approximately 80 % of the soil particles are larger than 0.02 mm. Thus, choosing a design particle size of 0.02 mm gives a theoretical trapping efficiency of approximately 80 %. In practice, and for more finely textured soils, the trapping efficiency would be less. However, as a general rule, it will not be necessary to design for a particle of size less than 0.02 mm, especially since the surface area requirement increases dramatically for smaller particle sizes. For example, a design particle of 0.01 mm requires about three times the surface area of 0.02 mm. Note also that choosing a V_{sed} of 0.00096 ft/sec equates to a surface area (SA) of 1250 sq. ft. per cfs of inflow.

- b. Settling depth (SD) should not be less than 2 feet and is also governed by the sediment storage volume surface area and relationship to the basin length (L). The basin length is defined as the average distance from the inlet to the outlet of the pond.

The ratio of L/SD should be less than 200.

The settling volume is therefore the surface area (SA) times the required settling depth.

To complete the design of the sediment pond:

Total sediment pond volume and dimension are determined as outlined below:

- a. Determine pond geometry for the sediment storage volume calculated above using 3 feet in depth and 3:1 side slopes from the bottom of the basin. Note, the basin bottom is level.
- b. Extend the pond side slopes (at 3:1 max.) as necessary to obtain the settling zone volume at 2-foot depth minimum or as determined above, 4-foot maximum.
- c. Adjust the geometry of the basin to effectively combine the settling zone volume and sediment storage volumes while preserving the depth and side slope criteria.

Provide baffles to prevent short-circuiting (see Figure 29). A 6:1 aspect ratio between the basin length and width of the pond is desirable.

Maintenance

- Inspections should be made regularly, especially after large storm events. Sediment should be removed when it fills one half of the pond's total sediment storage area. The effectiveness of a sediment pond is based less on its size than on regular sediment removal.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

Figure 31. Sedimentation Pond Baffles

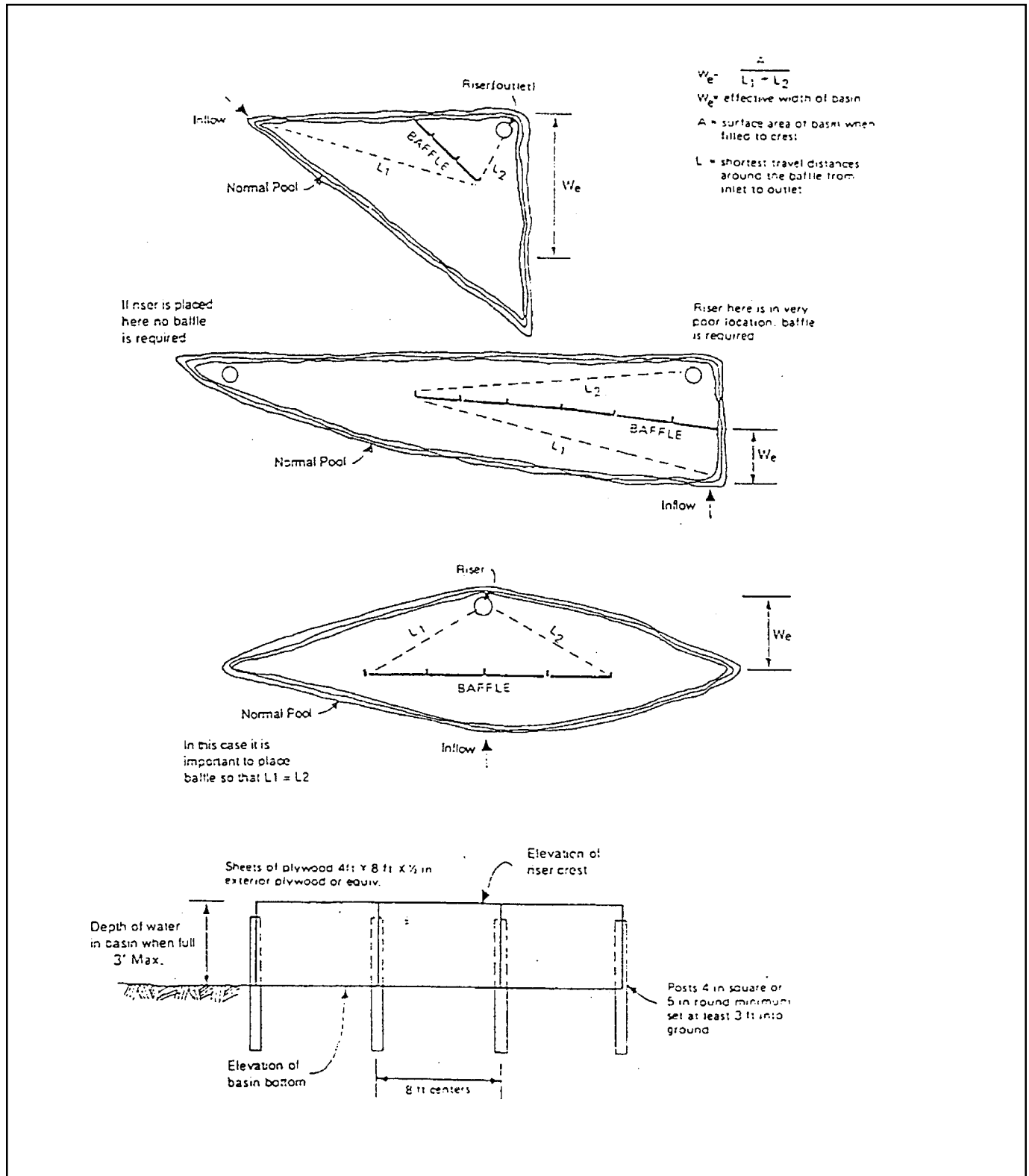
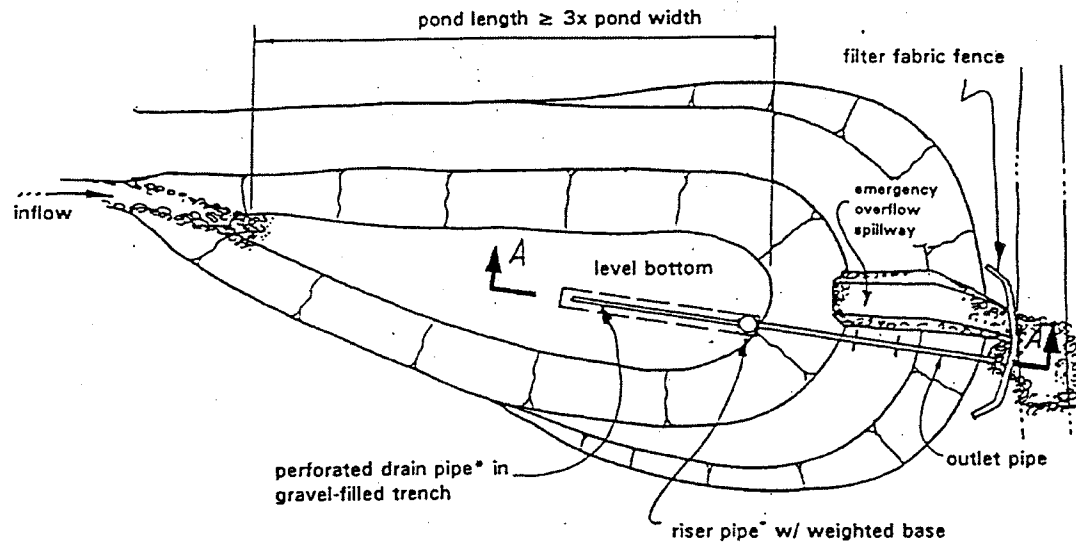
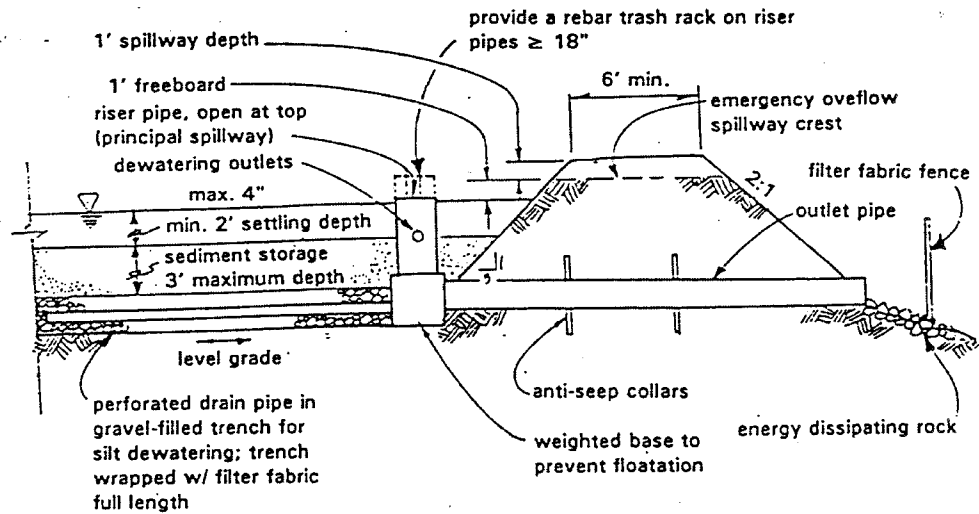


Figure 32. Sediment Pond



* Note: Sediment dewatering may be accomplished with perforated pipe in trench as shown or with a perforated riser pipe covered with filter fabric and a gravel "cone". A control structure may also be required; see Conditions Where Practice Applies





Chapter Four

Standards and Specifications for Construction Non-Erosion and Sedimentation Control (Pollutants Other Than Sediment) BMPs

Introduction

Potential pollutants other than sediment associated with construction activity, include numerous hazardous wastes as well as other solid and liquid wastes. Hazardous wastes include pesticides (insecticides, fungicides, herbicides, rodenticides etc.), petrochemicals (oils, gasoline, asphalt degreaser etc.) and other construction chemicals such as concrete products, sealer, paints, and wash water associated with these products. Other wastes include paper, wood, garbage, sanitary wastes, and fertilizer.

Practices must be used that prevent these potential pollutants from leaving the construction site. Good erosion and sediment control, coupled with stormwater management, will deter the movement of large amounts of sediment off the site. [It must be recognized, however, that pollutants carried in solution in runoff water, or fixed with sediment crystalline structures (e.g., crystalline clays), will be carried through the erosion and sediment control defenses.] Pollutants such as oils, waxes, and water-insoluble pesticides, form surface films on water and on solid particles, and also, oil films serve as a medium for concentrating water-soluble insecticides. Other than by use of very costly water-treatment facilities, or long runoff water detention periods, these pollutants become nearly impossible to control once present in the runoff.

The most economical and effective controls for pollutants other than sediment generated on construction sites, are the exercise of good “housekeeping” practices, and an awareness by construction workers, planners, engineers, and developers of the need and purpose of compliance with federal, state, and local regulations. For example, most pesticides can kill forms of life other than their pest targets. Certain insecticides can persist for months or years in soil and water, and many toxic chemicals can be passed along plant and animal food chains. Similarly, high levels of nutrients (principally phosphorus and nitrogen) from fertilizers used to revegetate exposed subsoils in graded areas may enter waterways and

ponds, and increase the growth of algae at the surface to such an extent that light penetration in the water column is decreased. The end result is over-enrichment (or eutrophication). In confined water bodies, over-enrichment can lead to complete deoxygenation of the water and consequent death of fish and other organisms.

Ways must be found to protect ponds, wetlands, lakes, streams, and coastal and estuarine water bodies from damage by sediment and other pollutants generated during construction activities.

The variety of pollutants and the severity of the damage they cause depend upon a number of factors. The most significant of these include:

1. The nature of the construction activity.
2. The physical characteristics of the construction site, including such factors as weather, time of year for construction, topography, soil condition, drainage systems, etc.
3. The proximity, quantity, and quality of the receiving waters (i.e., the amount and purity of the water receiving the contaminated runoff).

It is reasonable to expect, for example, that potential pollution resulting from fertilizers used during revegetation would be more severe on a highway or housing development than for a shopping center development. This is because highways and housing developments usually have far greater landscaping requirements than shopping centers that are composed mostly of rooftops and pavement.

The physical characteristics of the construction site have a major bearing on the potential severity of pollution from construction activities. As in the case of sediment, the vast majority of all pollutants are carried into the receiving waters via runoff. The amount of runoff coming from a construction site is dependent upon hydrologic factors. These include the amount, intensity, and frequency of rainfall; the infiltration rate of the soil; surface roughness; and the length and steepness of the ground slope. Large areas denuded or stripped of vegetation, long slopes, steep slopes, tight soils, and high intensity rainfall are all factors conducive to heavy runoff.

Another physical factor influencing the severity of pollution is the proximity of the pollutant, or potential pollutant, to the receiving water. For example, fertilizers applied to a streambank are more apt to cause water pollution than fertilizers applied to a slope well upland of the waterway.

BMPs


The following information deals with the nature and control of various construction-related pollutants, other than sediment.

BMP C1.10 Pesticide Control

Although the word “pesticide” has come to mean only those chemicals that attack insect populations, here the word is used to include herbicides and rodenticides as well as chemicals commonly known as pesticides. Insecticides, rodenticides, and herbicides have historically been used on construction sites to increase health and safety, maintain a pleasant environment, and reduce maintenance and fire hazards. Often, rodents are attracted to construction sites and rodenticides are used.

Pesticides shall only be used in conjunction with Integrated Pest Management (IPM). IPM utilizes a needs assessment that determines which method to use and the necessity of controlling a pest population. Pesticides should be the tool of last resort; methods which are the least disruptive to the environment and to human health should be used first (1). IPM as a BMP is further discussed in Volume IV, Chapter IV-4, BMP S1.90.

If pesticides must be used, clearance for use of any of these chemicals is often required by restrictive federal and state regulations. All pesticides should be stored and applied in accordance with regulations of the State Department of Agriculture, WAC 16-228-185. EPA has produced a pamphlet “Suspended, Canceled and Restricted Pesticides” (Jan. 1985), which includes information on many pesticides. As it is more than five years old, it is wise to check with EPA’s Region 10 Pesticides Branch, Seattle, if any questions regarding the use of pesticides arise. An awareness of the need to adhere to recommended dosages, type of application equipment, time of application, cleaning of application equipment, and safe disposal of these chemicals, will go far in limiting the pollution of waterways. Application rates should conform to registered label direction. Many of these compounds are considered “Dangerous Wastes” and must be disposed of properly. Disposal of excess pesticides and pesticide-related wastes should conform to registered label directions for the disposal and storage of pesticides and pesticide containers set forth in applicable federal, state and local regulations. General disposal procedures are:

- Dispose of through a licensed waste management firm or treatment, storage and disposal company (TSD).
- Use up, or give away to garden center, landscape service, etc.
- Triple rinse containers before disposal, reuse rinse waters as product.
- “Hazardous Waste Pesticides - Determining if Your Pesticide is a Hazardous Waste,” booklet #89-14 provides guidance and is available from Ecology’s Publications Office. For more information call Hazards Line at  (206) 587-3292 or Hazardous Substance Information Hotline (1-800-633-7585).
- Pesticide storage areas on the construction site should be protected from the elements, from vandals, and from the curious. Warning signals should be placed in areas recently sprayed or treated with the most dangerous pesticides. Persons involved in the mixing and application of these chemicals, to be in compliance with the law, must wear suitable protective clothing.

- Other practices include:
 - Set aside a locked, weather-resistant storage area.
 - Lids should be tightly closed.
 - Keep in a cool, dry place. Many pesticides rapidly lose their effectiveness if stored in areas exposed to heat.
 - In case of a leak, put original container into a larger container and label it properly.
 - Check containers periodically for leaks or deterioration.
 - Keep a list of products in storage.
 - Use plastic sheeting to line the area.
 - The applicator must follow the notification requirements of the WDSA. Neighbors on properties adjacent to the one being sprayed should also be notified prior to spraying.
 - All storage sheds, dumpsters or other storage facilities should be regularly monitored for leaks and repaired as necessary. Remind workers during subcontractor or safety meetings about proper storage and handling of materials.

BMP C1.20 Handling of Petroleum Products

Petroleum products are widely used during construction activities. They are used as fuels and lubricants for vehicular operations, power tools, and general equipment maintenance. These pollutants include oils, fuels such as gasoline, diesel oil, kerosene, lubricating oils, and grease. Asphalt paving can be a pollutant source as it continues to release various oils for a considerable length of time. Most of these pollutants adhere to soil particles and other surfaces easily.

One of the best modes of control is to retain sediments containing oil on the construction site. Soil erosion and sediment control practices can effectively accomplish this. Improved maintenance and safe storage facilities will reduce their chances of contaminating construction sites. One of the greatest concerns confronting uses of these petroleum products is the method for waste disposal. Oil and oily wastes such as crankcase oil, cans, rags, and paper dropped in oils and lubricants, can be best disposed of in proper receptacles or recycled (call 1-800-RECYCLE). Waste oil for recycling should not be mixed with degreasers, solvents, antifreeze, or brake fluid. The dumping of these wastes in sewers and other drainage channels is illegal and could result in fines or job shutdown. A further source of these pollutants is leaky vehicles. Proper maintenance of equipment and installation of proper stream crossings will further reduce pollution of water by these sources. Stream crossings should be minimized through proper planning of access roads.

Guidelines for storing petroleum products are as follows:

- Store products in weather-resistant sheds where possible.
- Create shelter around area with cover and wind protection.
- Line the storage area with double layer of plastic sheeting or similar material.
- Create impervious berm around the perimeter.
- Capacity of bermed area should be 110% of largest container.
- All products should be clearly labeled.
- Keep tanks off the ground.
- Keep lids securely fastened.
- Contact local fire marshall for more information.
- Post information for procedures in case of spills. Persons trained in handling spills should be on-site or on call at all times.
- Materials for cleaning up spills should be kept on-site and easily available. Spills should be cleaned up **immediately** and the contaminated material properly disposed of.
- Specify a staging area for all vehicle maintenance activities. This area should be located away from all drainage courses.
- All storage sheds, dumpsters or other storage facilities should be regularly monitored for leaks and repaired as necessary. Remind workers during subcontractor or safety meetings about proper storage and handling of material

BMP C1.30 Nutrient Application Control

Fertilizers used to revegetate graded areas are the primary cause of inorganic nutrient pollution. The use of proper soil-stabilization measures, sediment control, and stormwater detention structures can be effective means of keeping these materials out of waterways. Only small amounts of inorganic nutrients are beneficial to the productivity of waterways, while excess amounts result in over-enrichment (eutrophication).

Nutrient pollution can be minimized by working fertilizers and liming materials into the soil to depths of 4 to 6 inches, and by proper timing of the application. Hydro-seeding operations, in which seed, fertilizers and lime are applied to the ground surface in a one-step operation, are more conducive to nutrient pollution than are conventional seedbed-preparation operations, where the fertilizers and lime are tilled into the soil. In the case of surface dressings, control can be achieved by applying the required quantity of fertilizer in more than one operation. For example, an area requiring an application of 500 lbs. per acre of fertilizer could be dressed with about 125 lbs. per acre at four separate times over the growing season.

Local authorities may require use of fertilizers containing little or no phosphorus if the development is near sensitive water bodies. In any event great care should be taken to use only the minimum amount of phosphorus needed, as determined by soil tests, or advice from the local Conservation District or Soil Conservation Service.

Near sensitive surface waters, the addition of lime can affect the pH (or acidity) of runoff and receiving waters. Importation of topsoil is better than heavily liming and fertilizing exposed subsoil.

BMP C1.40 Solid Waste Handling Disposal

Solid waste is one of the major pollutants caused by construction. Solid waste is generated from trees and shrubs removed during land clearing for construction of streets and parking facilities, and during the installation of structures. Other wastes include wood and paper from packaging and building materials, scrap metals, sanitary wastes, rubber, plastic and glass pieces, masonry products, and others. Food containers such as beverage cans, coffee cups, lunch-wrapping paper and plastic, cigarette packages, leftover food, and aluminum foil contribute a substantial amount of solid waste to the construction site.

The major control mechanism for these pollutants is to provide adequate disposal facilities. Collected solid waste should be removed and disposed of at authorized disposal areas. Frequent garbage removal helps maintain construction sites in a clean and attractive manner. Waste containers should be labeled and located in a covered area. Lids should be kept closed at all times. Any useful materials should be salvaged and recycled. For instance, masonry waste can be used for filling borrow pits; trees and brush from land-clearing operations can be converted into woodchips through mechanical chippers and then used as mulch in graded areas. Sanitary facilities must be convenient and well maintained to avoid indiscriminate soiling of adjacent areas. Selective (rather than wholesale) removal of trees is helpful in conservation of soil and reduction of wood wastes. Indiscriminate removal of trees and other beneficial vegetation should be avoided.

Soil erosion and sediment control structures capture much of the solid waste from construction sites. Constant removal of litter from these structures will reduce the amount of solid waste despoiling the landscape. The extension of local and state anti-litter ordinances to cover construction sites is also a viable control mechanism. Adherence to these regulations by construction personnel reduces unnecessary littering through carelessness and negligence.

BMP C1.50 Use of Chemicals During Construction

Many types of chemicals may be used during construction activities. These chemical pollutants include paints, acids for cleaning masonry surfaces, cleaning solvents, asphalt products, soil additives used for stabilization and other purposes, concrete-curing compounds, and many others. These materials are carried by sediment and runoff from construction sites.

A large percentage of these pollutants can be effectively controlled through implementation of source control soil erosion and sedimentation control practices. Using only the recommended amounts of these materials and applying them in a proper manner can further reduce pollution. As in the case of other pollutants, good housekeeping is the most important means of controlling pollution.

The correct method of disposal of wastes varies with the material. Wash-up waters from water-based paints may go into a sanitary sewer, but wastes from oil-based paints, cleaning solvents, thinners, and mineral spirits must be disposed of through a licensed waste management firm or TSD. Disposal of concrete products, additives, and curing compounds depends on the product. Information is available from the local health department or the Hazardous Substance Information Hotline (1-800-633-7585).

Other Pollutants

Other pollutants include concrete wash water from concrete mixers, acid and alkaline solutions from exposed soil or rock units high in acid, and alkaline-forming natural elements.

The control of these pollutants involves good site planning and pre-construction geological surveys. Neutralization of these pollutants often provides the best treatment. Sealing of fractures in the bedrock with grout and bentonite will reduce the amount of acid or alkaline seepage from excavations. Adequate treatment and disposal of concrete further reduces pollution.

General Guidelines

General guidelines for managing or minimizing any of the above hazardous wastes are as follows:

BMP C1.60 Managing Hazardous Products

- Buy and use only what is needed. Leftovers need to be stored, re-used, given away, recycled or disposed of safely.
- Read labels and follow directions on the label. Hazardous products may be labeled:

Danger	Poisonous	Volatile	Caution
Combustible	Caustic	Explosive	
Warning	Corrosive	Flammable	
- Try to keep products in original containers and always keep them well labeled. If the product must be transferred to smaller containers, use the proper size funnel and avoid spills. Label all containers.
- Labels can fall off with weathering. To prevent, cover with transparent tape. To relabel, use a metal tag attached to the container or use a stencil and spray paint.
- Do not mix chemical substances unless recommended by the manufacturer.
- Use in well-ventilated areas. Protect skin, eyes, nose, and mouth when necessary by wearing gloves, respirator, or other protective clothing.
- Keep corrosive liquids away from flammable liquids.
- Look for nontoxic or less toxic options (check with the State Department of Ecology Office of Waste Reduction at 1-800-822-9933).
- Use the entire product before disposing of the container.
- There are private firms that specialize in the cleanup of spills.

BMP C1.70 Equipment Washing

Thinners or solvents should **not** be discharged into the sanitary or storm sewer systems when cleaning large machine parts where discharge of water is required. Use alternative methods for cleaning larger equipment parts such as high pressure, high temperature water washes, or steam cleaning.

Equipment washing detergents can be used and wash water discharged into the sanitary system if grit is removed from the solution first. The water discharged into the sewer must not exceed the discharge limits set by the Sewer Authority.

Small parts can be cleaned with degreasing solvents that are reused after filtering or recycled. These solvents should **not** be discharged into any sewer. Further information is available from the Department of Ecology.

BMP C1.80 Spill Control Planning and Cleanup

Construction site supervisors shall adopt a spill control plan and identify persons responsible for implementing the plan if a spill of a dangerous or hazardous waste should occur. Any spill that occurs, regardless of the size and/or type of spill, should be reported to the following agencies:

- If the spill of a hazardous substance could reach surface waters, the following agencies must be notified (there are fines for failing to notify):
 - National Response Center 1-800-424-8802 (24-hour)
 - Locally, notify the regional Department of Ecology offices:
 - Northwest Region - Redmond (425) 649-7000 (24-hour)
 - Southwest Region - Olympia (360) 753-2353 (24-hour)
 - Within the City of Bellevue Storm & Surface Water Utility (425) 455-7846 (24-hour)
 - For spills within salt water - U.S. Coast Guard (206) 286-5440

There are fines for failing to notify the appropriate authority when a spill occurs.

Some of the important components of a spill control plan are:

- Establish whom to notify in the event of a spill, particularly if it is hazardous.
- Provide specific clean-up instructions for different products handled on site.
- Assign a person to be in charge of clean-up assistance.
- Prepare spill containment and clean-up lists that are easy to find and use.
- Post a summary of the clean-up plan at appropriate locations.
- If a spill occurs, demobilize it as quickly as possible.
- If there is a change that the spill could enter a storm drain or sewer, plug the inlet and turn off or divert any incoming water.
- Cover the spill with absorbent material such as kitty litter or sawdust. Do not use straw. Dispose of the used absorbent per Ecology or manufacturer's instructions. If the spill is flammable, dispose of as directed by the local fire marshal.
- Keep the area well ventilated.

BMP C1.90 Treatment and Disposal of Contaminated Soils

Contaminated ground water or soil may be encountered during earthwork activities or by the spill or leak of a hazardous product. The contaminant may be known or unknown. Sampling and laboratory tests may be required to determine whether a landfill can accept the contaminated soil. In some cases it is possible to reduce the hazardous potential of the soil by aerating it, for example. Local health departments can supply the necessary procedures. Private firms can also be consulted for disposal.

The Model Toxics Control Act, Ch. 70.105 RCW, requires that Ecology's Toxic Cleanup Program be notified if contaminated soil or ground water is encountered during a project.

BMP C 2.00 Concrete Trucks/Spray Washing of Exposed Aggregate Driveways and Walkways

The washout from a concrete truck should be disposed of into:

- A designated area that will later be backfilled: a slurry pit.
- An area where the concrete wash can harden, be broken up, and then put in the dumpster.
- A location which is not subject to surface water runoff, and more than 50 feet away from a storm drain, open ditch, or receiving water.

Never Dump Into:

- Sanitary sewer
- Storm drain
- Soil or pavement that carries stormwater runoff.

When spray washing driveways or walkways to expose the aggregate, all wash water should be diverted or sprayed to the sides, not down the driveway. If water must run down the driveway towards the street or sidewalk, it should be diverted at the bottom to a sump or sediment trap.

BMP C2.10 Use of Sandblasting Grits

If used to clean old buildings where lead, cadmium, or chrome-based paints were applied, the sandblasting grits are a hazardous waste. They cannot be washed into any sewer system. Contact a licensed waste management firm or TSD facility.

BMP C2.20 Disposal of Asbestos and PCBs

Use and disposal of these potential pollutants are regulated by both state and federal agencies. For further information, contact:

For Asbestos:

Puget Sound Air Pollution Control Agency: (206) 296-7330

U.S. EPA: (206) 442-7369

For Wastes Containing PCBs:

Washington Department of Ecology, Hazardous Waste Section: (206) 449-6687

U.S. EPA: (206) 442-7369

References

Washington Toxics Coalition, letter dated January 31, 1990.

Reinelt, Loren, Construction Site Erosion and Sediment Control Inspector Training Manual, Center for Urban Water Resources Management, University of Washington, October, 1991.